
"Verticals are poor antennas and radiate poorly in all directions."
who? when?

PACIFICON℠ 2022

San Ramon Marriott
2600 Bishop Drive
San Ramon, CA 94583

<u>IN PERSON!</u>
Friday through Sunday
Oct. 14-16, 2022


Get Some!

Some what?

Have I got any of it now?

I found a book entitled,
“How to solve 50% of your problems”,

I bought two.

Since this is THE Antenna Forum:

Why do I need an antenna?

What design does what?

Simple answer:

to get your signal (RF) from “Point A” (you)

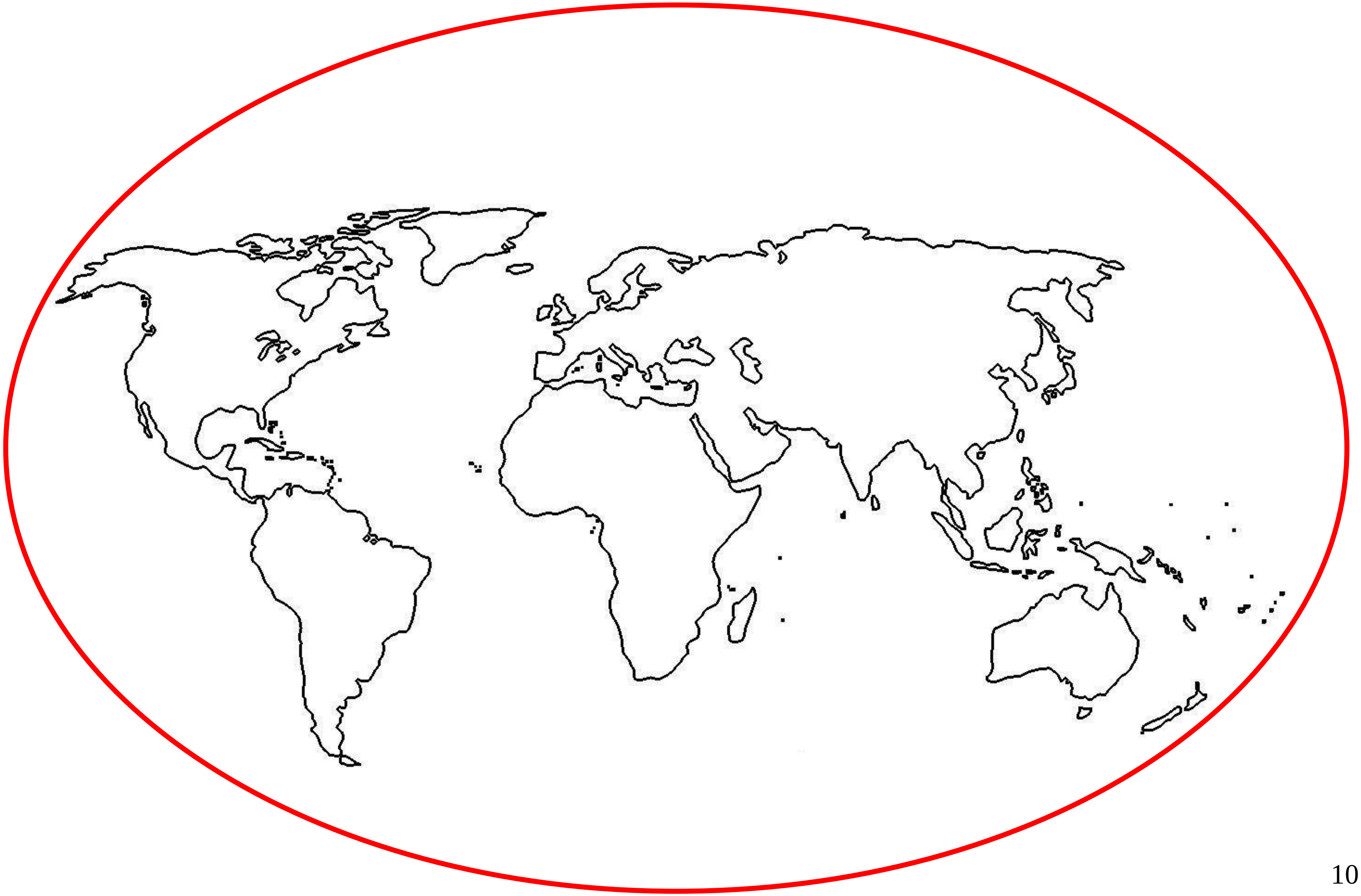
to

“Point B” (someone else).

Operate mainly VHF/UHF

HF with minimal power and antenna

HF with more power and efficient/gain antenna



To make a Q, how much power do I need?

Actually – maybe the question should be,
"How much ERP do I need?"

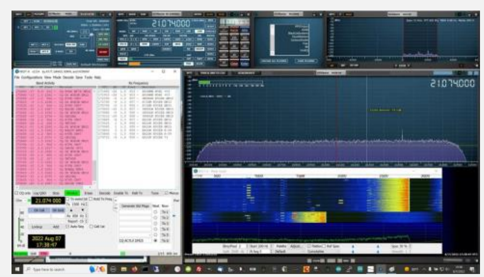
How strong do I need to be to make a Q?

What mode am I running?

SSB?

CW?

FT-8?



Which requires the strongest signal at Point B?

I. Sometimes, less than 5 watts and a simple, single element antenna will do the job.

___The band is obviously open – the propagation conditions are favorable.

II. Other times, you can hear the distant station and even with a gain antenna, running all the juice you can muster, you get no response from Point B.

___Although band conditions show the path is available, it seems “one way.”

Is there such a thing?

Well, yes, there is.

True “one-way” propagation does exist, as I have experienced it from the Union of Myanmar on the low bands (80 and 160). It seems to be unique and most often from that geographic area.

More often than being “one way” (presuming our signal is getting to Point B):

not making a Q is caused by local conditions on the far end of the circuit, where local noise is masking the incoming signals.

Our signal is too far down in the noise
(local noise)

Of course, it could be -

our signal isn't getting there at all!

If the propagation is adequate, our signal needs to be heard in the audio output of the receiver.

For voice (SSB) and CW, it needs to be audible;

however,

for FT-8, we do *not* need to hear it.

The decoding software *alone* needs to hear our signals.

Note to self: FT-8 is a great mode for those with hearing difficulties.

How much difference might there be between
an audible CW signal and a decodable FT-8 signal in the audio?

____FT-8 “says” it can decode at -22dB, maybe even -24.

____When do we no longer hear CW to decode it ourselves?

Or, how much “advantage” is there to FT-8 (digital)?

From the website: https://physics.princeton.edu/pulsar/k1jt/wsjtx.html

WSJT-X implements communication protocols or "modes" called **FST4, FST4W, FT4, FT8, JT4**, **JT9**, **JT65**, **Q65**, **MSK144**, and **WSPR**, as well as one called **Echo** for detecting and measuring your own radio signals reflected from the Moon. These modes were designed for making reliable, confirmed QSOs under extreme weak-signal conditions.

How weak can we go?

How weak can we go?

FT-8 operates from the receiver's audio, BUT the FT-8 signals do not need to be audible by us, as with other modes such as SSB and CW.

__CW has been a "weak signal" mode on HF for a very long time.

__Does FT-8 really offer a substantial margin for communicating?

https://www.ok2kkw.com/next/cw_versus_ft8.htm

https://olgierd.github.io/ft8-vs-cw

CW @ 300Hz -7

CW @ 300Hz -10

CW @ 300Hz -12

CW @ 300Hz -22

ft8-vs-cw

FT8 vs CW

Signal-to-noise	FT8 decode level	WAV FT8	WAV CW 2700Hz	WAV CW 300Hz	WAV CW 100Hz	WAV CW 20Hz
13 to 150	-22	GET	GET	GET	GET	
14 to 150	-22	GET	GET	GET	GET	
15 to 150	-21	GET	GET	GET	GET	
20 to 150	-18	GET	GET	GET	GET	GET
25 to 150	-17	GET	GET	GET	GET	GET
30 to 150	-15	GET	GET	GET	GET	GET
35 to 150	-14	GET	GET	GET	GET	GET
40 to 150	-13	GET	GET	GET	GET	
45 to 150	-12	GET	GET	GET	GET	
50 to 150	-11	GET	GET	GET	GET	
55 to 150	-10	GET	GET	GET	GET	
60 to 150	-9	GET	GET	GET	GET	
65 to 150	-8	GET	GET	GET	GET	
70 to 150	-8	GET	GET	GET	GET	
75 to 150	-7	GET	GET	GET	GET	
80 to 150	-7	GET	GET	GET	GET	
90 to 150	-6	GET	GET	GET	GET	
100 to 150	-5	GET	GET	GET	GET	

Conclusion: FT-8 is approximately +10dB margin to CW, maybe a bit more

Comments re: FT-8

FT8 is a WEAK SIGNAL MODE NOT A LOW POWER MODE.

That said use only the power your need to use to make the contact.

Often hear about “running power” and the common statement is like, “I don’t need to.”

If the other station is weak.. say -22 or less,
then it is likely you will need to “use power” for the station to hear you.

How much "effective QSO power" (EQP) are you putting towards "Point B" compared to CW?

Are you running 5 watts?

With +18dB, your ERP is: **320 watts** to Point B w/o FT-8.

Running 50 watts?

With +18dB, your ERP is: **3200 watts** to Point B w/o FT-8.

MAGNETICS

Check the transceiver specs for running digital mode.

On the Elecraft Groups, the KX-3 is suggested to run at max 5 watts, without the aftermarket Pro Audio Engineering heat sink and an external fan.

The issue is the output bandpass filters and their ability to dissipate the heat.

<u>This is not unique to Elecraft</u>

Given the same propagation conditions, the ***margin*** between signals *heard/not heard* can be from:

__Different power levels, which are easy to identify and quantify (e.g. 5 watts, 1KW).

____Different antennas, which are not so simple as power comparisons.

___Antennas run the gamut from multi-element Yagis on tall towers (i.e. gain antennas with lobes at low angles) to simple antennas, such as a sloping EFHW.

LUSO 170' telescoping, rotating tower

Overall, regardless of the station's set-up, it must

Get Some

energy to Point B.

Determining the difference ***in power*** is straightforward, but the differences ***between antennas*** is not.

As a starting point, how about…..

…..use our “discovered” 10dB margin between CW and FT-8

Is 10dB a big deal?

If you watch Youtube, for example, you often hear that being down 3dB, even 6dB is nothing when you’re 20 over.

Question: when using low power and a compromised antenna, are you ever 20 over 9?

…..use our "discovered" 10dB margin between CW and FT-8

Is 10dB a big deal?

If you watch Youtube, for example, you often hear that being down 3dB, even 6dB is nothing when you're 20 over.

Question: when using low power and a compromised antenna, are you ever 20 over 9?

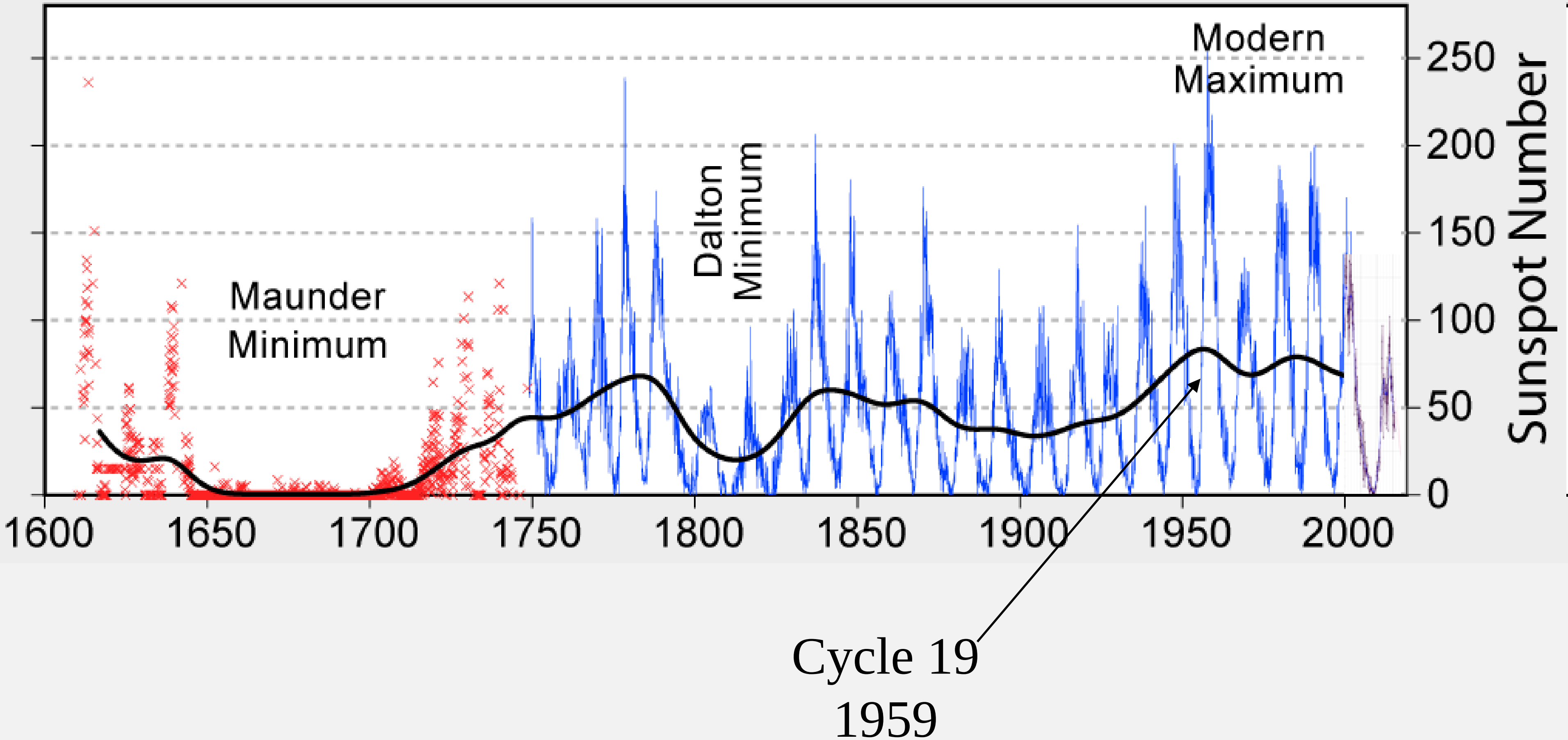
"compromised?"

Yes → when the pattern is unknown and efficiency is far from being >80%.

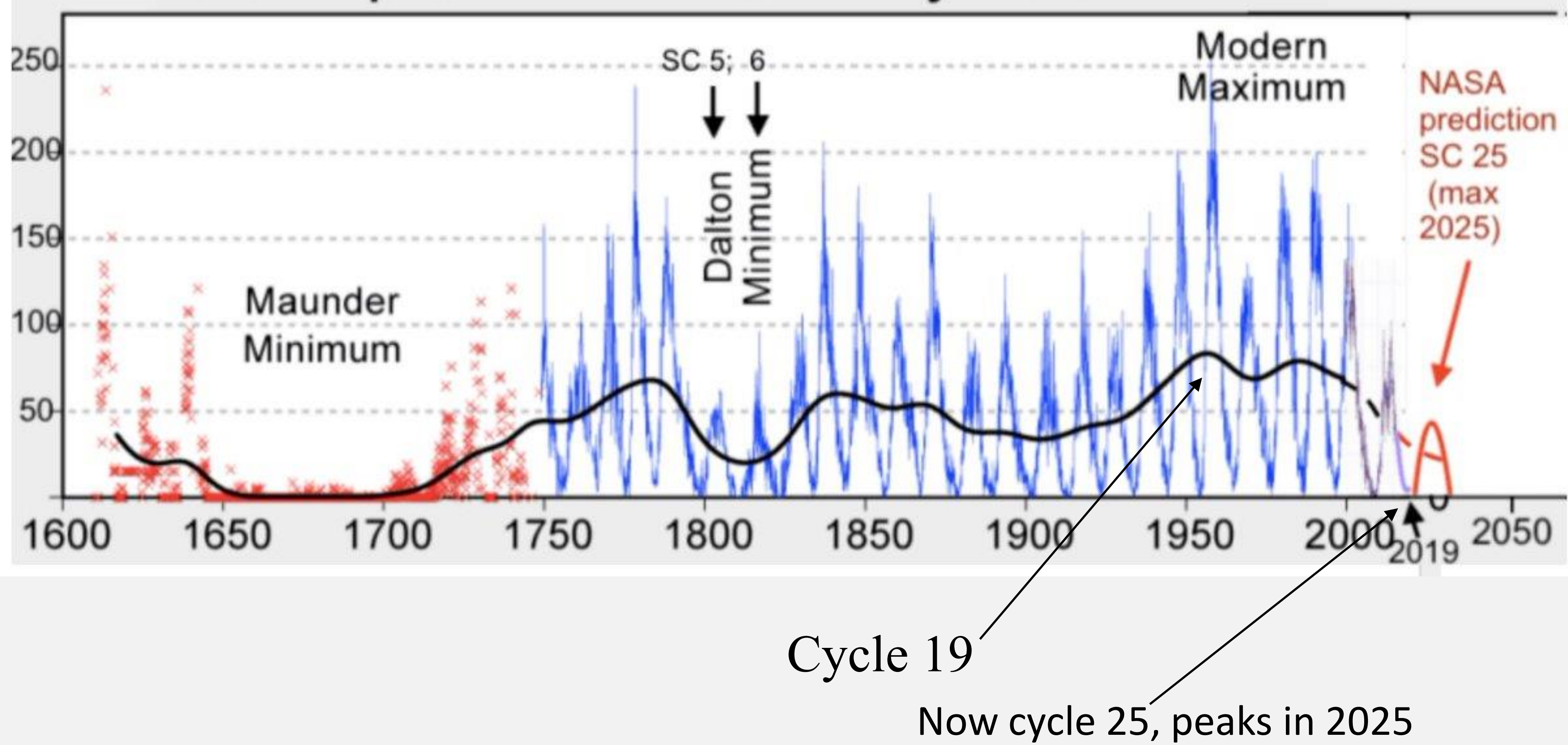
Licensed in ’59, which was the most impressive propagation in the last 100 years;

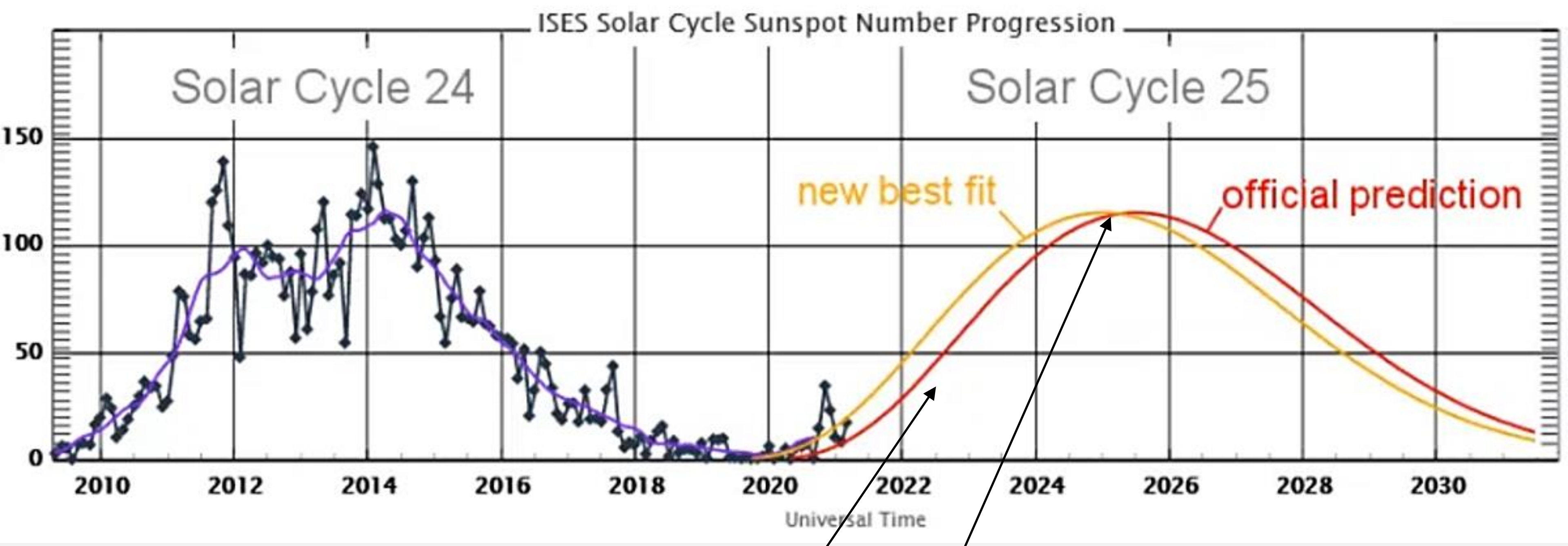
anything, everything “worked” as an antenna

400 Years of Sunspot Observations



NASA prediction Solar Cycle 25





Now

Cycle 25, peaks in 2025

Was asked what antennas I have used, used in competition, or tested, particularly before starting Force 12, Inc. in 1991

and
which antenna(s) stood out?

Window screen
Windom
TA-32 trapped 2el tribander
Wire 40 meter vertical, ground rod
Verticals adjacent to buildings
2el 20 mtr Quad (wide spaced)
2el 15/10 mtr Quad
Sloping long wire 80/40
Inverted V 40 mtr Dipoles
Rhombic 40-mtr
4el 40 mtr broadside phased vertical array
4el 20 mtr Yagi
2, 3 and 4el KLM linear loaded 40 mtr Yagi
HyGain 4el 10
HyGain 4el 15
HyGain 4el 20
HyGain 205B (long boom 5el 20)
6el 10 Yagi (HyGain parts)
6el 15 Yagi (HyGain parts)
Create 80/75 dipole
80 mtr inverted V
80 mtr HB rotatable dipole
Stacked 1 over 1 40 mtr dipoles
Stacked 5el 20 HyGain Yagis
3el 40 KLM /5el 20 HyGain Yagi
4el20 CushCraft Yagis (4/4)
4el15 CushCraft Yagis (4/4)
4el10 Cushcraft Yagis (4/4)
2el40 CushCraft Yagi
80mtr inverted V
160 balloon vertical
KLM 80/75 linear loaded dipole
KLM 2el 80/75 linear loaded Yagi
80mtr 4-square HyGain Hy Towers
Mosley Pro-96 large trapped tribander
Mosley 402 2el 40 Yagi
CushCraft A3 trapped tribander
CushCraft A3S
CushCraft A4 (with 40)
KLM KT-34XA
KLM KT-34 (short)
KLM KT-34XA 3-stack
HyGain 205BA/CA
Mobile Mosley trapped driver
Mobile Mosley TA-32 2el trapped tribander
HyGain linear loaded 40 dipole
HyGain linear loader 2el40 Yagi
Gap vertical (80-10)
R-5 vertical
R-7 vertical
Bencher vertical – HF-2V
F.E.B.C. Saipan arrays – TCI-611 curtains
RingoRanger 2mtr
Many 2mtr mobile mag-mount
HyGain TH-6, TH-7
HyGain TH-2, TH-3
HyGain Explorer-14
Butternut HF-2V vertical
HyGain 204BA w/2el KLM 40
HyGain 5el15 (modified)
HyGain 6el10 (modified)
HyGain 205B modified to 6el w/2el40
Create longer 80/75 rotatable dipole
160 shunt fed tower
TCI-611 curtain arrays (Far East Broadcasting)
Sloping dipole for 160
Sloping dipole for 80
Sloper arrays for 40
3el 10 mtr Yagi “Tail gunner”
DXpedition 80 dipole, linear loaded
Beverage Receiving Antennas
Vertical dipole

Window screen
Windom
TA-32 trapped 2el tribander
Wire 40 meter vertical, ground rod
Verticals adjacent to buildings
2el 20 mtr Quad (wide spaced)
2el 15/10 mtr Quad
Sloping long wire 80/40
Inverted V 40 mtr Dipoles
Rhombic 40-mtr
4el 40 mtr broadside phased vertical array
4el 20 mtr Yagi
2, 3 and 4el KLM linear loaded 40 mtr Yagi
HyGain 4el 10
HyGain 4el 15
HyGain 4el 20
HyGain 205B (long boom 5el 20)
6el 10 Yagi (HyGain parts)
6el 15 Yagi (HyGain parts)
Create 80/75 dipole
80 mtr inverted V
80 mtr HB rotatable dipole
Stacked 1 over 1 40 mtr dipoles
Stacked 5el 20 HyGain Yagis
3el 40 KLM /5el 20 HyGain Yagi
4el20 CushCraft Yagis (4/4)
4el15 CushCraft Yagis (4/4)
4el10 Cushcraft Yagis (4/4)
2el40 CushCraft Yagi
80mtr inverted V
160 balloon vertical
KLM 80/75 linear loaded dipole
KLM 2el 80/75 linear loaded Yagi
80mtr 4-square HyGain Hy Towers
Mosley Pro-96 large trapped tribander
Mosley 402 2el 40 Yagi

CushCraft A3 trapped tribander
CushCraft A3S
CushCraft A4 (with 40)
KLM KT-34XA
KLM KT-34 (short)
KLM KT-34XA 3-stack
HyGain 205BA/CA
Mobile Mosley trapped driver
Mobile Mosley TA-32 2el trapped tribander
HyGain linear loaded 40 dipole
HyGain linear loader 2el40 Yagi
Gap vertical (80-10)
R-5 vertical
R-7 vertical
Bencher vertical – HF-2V
F.E.B.C. Saipan arrays – TCI-611 curtains
RingoRanger 2mtr
Many 2mtr mobile mag-mount
HyGain TH-6, TH-7
HyGain TH-2, TH-3
HyGain Explorer-14
Butternut HF-2V vertical
HyGain 204BA w/2el KLM 40
HyGain 5el15 (modified)
HyGain 6el10 (modified)
HyGain 205B modified to 6el w/2el40
Create longer 80/75 rotatable dipole
160 shunt fed tower
TCI-611 curtain arrays (Far East Broadcasting)
Sloping dipole for 160
Sloping dipole for 80
Sloper arrays for 40
3el 10 mtr Yagi “Tail gunner”
DXpedition 80 dipole, linear loaded
Beverage Receiving Antennas
Vertical dipole

A3S

Band Coverage: 20,15,10 mtrs
Antenna Gain: 8.0 dBi
Antenna F/B (dB): 25.0 dB
BW 2:1 VSWR: **>**500 kHz

Saipan, 1983

1983 AH0C WA6VEF (VA7RR) **& N6BT**
M/M (2 tx each), finished 4th worldwide

A3S on 30’ mast at edge of 400’ cliff

TCI-611 curtains x 3 also at edge of 400’ cliff

Difference between A3S and TCI-611 to HZ1?
>50dB

TCI
AN SPX COMPANY

MODEL **611**
Shortwave Broadcast Antenna

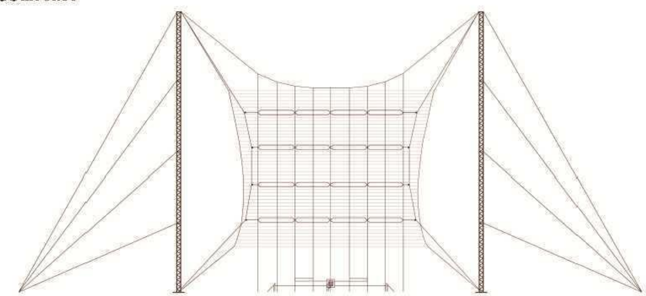
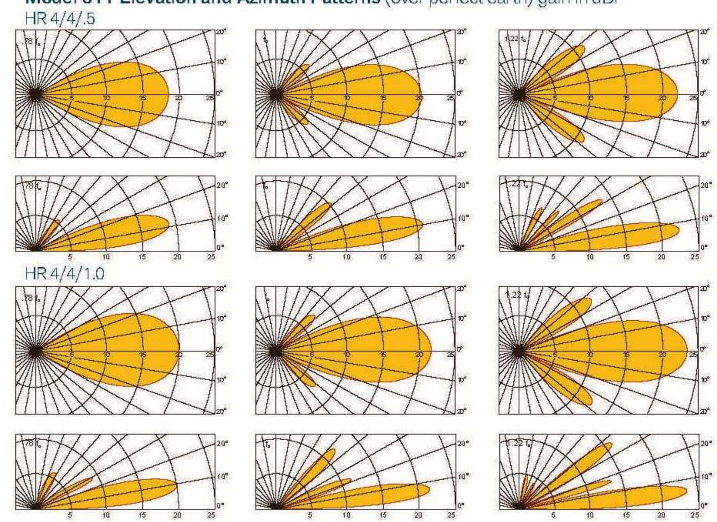


Figure 2. Gain in dBi of Dipole Curtain Array with perfect reflecting screen spaced 0.3 wavelengths from elements

Number of elements in vertical stack (m) (1/2 wavelength spacing)	Number of half-wave elements wide (n)															
	1				2				3				4			
	Height above ground of lowest element in wavelengths (h).															
	0.25	0.50	0.75	1.0	0.25	0.50	0.75	1.0	0.25	0.50	0.75	1.0	0.25	0.50	0.75	1.0
1	12.5	13.2	14.0	13.6	13.5	14.4	15.3	14.8	15.4	16.4	17.1	16.8	16.1	17.2	17.9	17.5
2	14.0	15.0	15.6	15.8	15.4	16.5	17.0	17.2	17.5	18.4	19.0	19.2	18.2	19.3	19.8	20.0
3	15.6	16.4	16.9	17.2	17.1	17.9	18.4	18.7	19.0	19.8	20.3	19.6	19.8	20.7	21.2	21.5
4	16.7	17.3	17.9	18.2	18.2	18.9	19.4	19.7	20.1	20.8	21.3	21.6	21.0	21.7	22.2	22.5

Model 611 Elevation and Azimuth Patterns (over perfect earth) gain in dBi



The only antenna I have used that compares to the curtain arrays is a 2x2 vertical array on the beach

What are we looking for?

What should be our goal?

Let’s take a quick look at “Internet *opinions*”

I can generally hear many more stations than can hear me, so I usually keep the rf gain backed off a bit, which also reduces noise. The transmitting antenna is the big key to being heard, as you said. I have also found that if they can't hear me on 100 watts, then kicking it up to 500 watts doesn't really help much.
100 to 500 watts is +7dB and no joy

Re: radials: Somewhere between 2 and 4 wavelengths of wire, 180 degrees or only 90 degrees of ground w/radials and you'll still get out.
You'll never notice. It will work and you will still have a ball.
Regardless, you will always be within 3dB of "perfect." (Referring to N6LF data.)
3dB is inconsequential

I literally worked all over the world today with 5 watts on ft8. It wasn't too hard, but a lot of stations had a hard time copying me.
3dB would certainly help

Upgrading my feed-line from RG8X to LMR600 lowered my noise floor from S7 to S1-2, massively improving what I am able to receive.
Not addressing loss; however, an example → 100' with 2:1 at the load:
RG-8X with 2:1 on 10 meters is -1.8dB and LMR-600 is -0.5dB
Changing coax picked up 1.3dB (aka "gain coax")

We also know from our "hearing test", that FT-8 is maybe 10dB better than CW

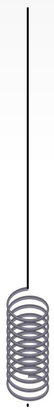
If you have listened to my comments from Team Vertical's many Contest Expeditions and setting>25 World Records, enhancing by 2dB is another layer of stations

Where/how can you get at least 3dB? How about 7?

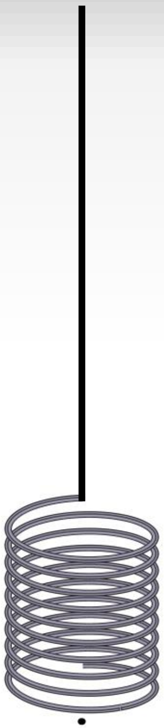
Maybe it is as simple as turning up the wick:

more power

Higher efficiency in the antenna system:



$60\% \rightarrow 90\% = 3dB$



Less Loss

Maybe re-evaluating our tuner / location.

43' vertical with (4) #12 41' radials over 20,30 ground;
fed with 100' of RG-213 with the tuner at the radio
tuner data calculated from "TLW" software by Dean Straw, N6BV

Band	Feed Point	Tuner Type	Tuner Loss	Coax Loss	Total Loss	1,500w to tuner, actual to antenna
40	87 +j195	HiPass L	-36w	-2.15dB	-2.25dB	893w
40	87 +j195	LoPass pi	-102w	-2.15dB	-2.45dB	853w
40	87 +j195	HiPass T	-120w	-2.15dB	-2.51dB	842w

The VSWR at the feed point is approximately 11:1
Using the Loss formula, the loss at the unmatched feed point is $10 * \log_{10} (1- (vswr-1/vswr+1)^2)$
$= 10 * \log_{10} (0.3055557) = 10 * -0.51490 = -5.15$ dB

Band	Feed Point	Tuner Type	Tuner Loss	Coax Loss	Total Loss	1,500w to tuner, actual to antenna
20	74 – j447	HiPass L	-29w	-7.82dB	-7.91dB	243w
20	74 – j447	LoPass pi	-95w	-7.82dB	-8.11dB	232w
20	74 – j447	HiPass T	-229w	-7.82dB	-8.54dB	210w

The VSWR at the feed point is approximately 57:1
Using the Loss formula, the loss at the unmatched base (feed point) is $10 * \log_{10} (1- (vswr-1/vswr+1)^2)$
$= 10 * \log_{10} (0.0677766) = 10 * -1.1689 = -11.69$ dB

Band	Feed Point	Tuner Type	Tuner Loss	Coax Loss	Total Loss	1,500w to tuner, actual to antenna
75	13 – j380	HiPass L	-108w	-10.08dB	-10.41dB	137w
75	13 – j380	LoPass pi	-182w	-10.08dB	-10.64dB	129w
75	13 – j380	HiPass T	-637w	-10.08dB	-12.48dB	85w

The VSWR at the feed point is approximately 232:1
Using the Loss formula, the loss at the unmatched base (feed point) is $10 * \log_{10} (1- (vswr-1/vswr+1)^2)$
$= 10 * \log_{10} (0.0170938) = 10 * -1.7672 = -17.67$ dB

Maybe re-evaluating our tuner / location.

43' vertical with (4) #12 41' radials over 20,30 ground;
fed with 100' of RG-213 with the tuner at the radio
tuner data calculated from "TLW" software by Dean Straw, N6BV

Band	Feed Point	Tuner Type	Tuner Loss	Coax Loss	Total Loss	1,500w to tuner, actual to antenna
40	87 +j195	HiPass L	-36w	-2.15dB	-2.25dB	893w
40	87 +j195	LoPass pi	-102w	-2.15dB	-2.45dB	853w
40	87 +j195	HiPass T	-120w	-2.15dB	-2.51dB	842w

The VSWR at the feed point is approximately 11:1
Using the Loss formula, the loss at the unmatched feed point is $10 * \log_{10} (1- (vswr-1/vswr+1)^2)$
$= 10 * \log_{10} (0.3055557) = 10 * -0.51490 = -5.15$ dB

Band	Feed Point	Tuner Type	Tuner Loss	Coax Loss	Total Loss	1,500w to tuner, actual to antenna
20	74 –j447	HiPass L	-29w	-7.82dB	-7.91dB	243w
20	74 –j447	LoPass pi	-95w	-7.82dB	-8.11dB	232w
20	74 –j447	HiPass T	-229w	-7.82dB	-8.54dB	210w

The VSWR at the feed point is approximately 57:1
Using the Loss formula, the loss at the unmatched base (feed point) is $10 * \log_{10} (1- (vswr-1/vswr+1)^2)$
$= 10 * \log_{10} (0.0677766) = 10 * -1.1689 = -11.69$ dB

Band	Feed Point	Tuner Type	Tuner Loss	Coax Loss	Total Loss	1,500w to tuner, actual to antenna
75	13 –j380	HiPass L	-108w	-10.08dB	-10.41dB	137w
75	13 –j380	LoPass pi	-182w	-10.08dB	-10.64dB	129w
75	13 –j380	HiPass T	-637w	-10.08dB	-12.48dB	85w

The VSWR at the feed point is approximately 232:1
Using the Loss formula, the loss at the unmatched base (feed point) is $10 * \log_{10} (1- (vswr-1/vswr+1)^2)$
$= 10 * \log_{10} (0.0170938) = 10 * -1.7672 = -17.67$ dB

The tuner belongs at the antenna

Increasing efficiency in the antenna system:

Higher efficiency Verticals → improve the current return

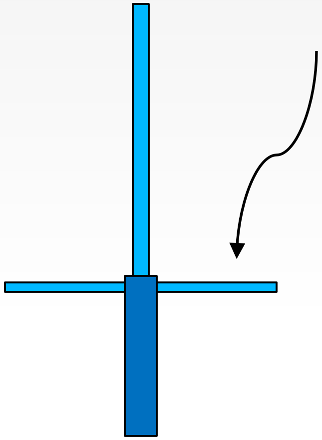
Correcting radial lengths = up to 3dB

Various on-ground radials to resonators, Gull Wing, VOR = 3+dB

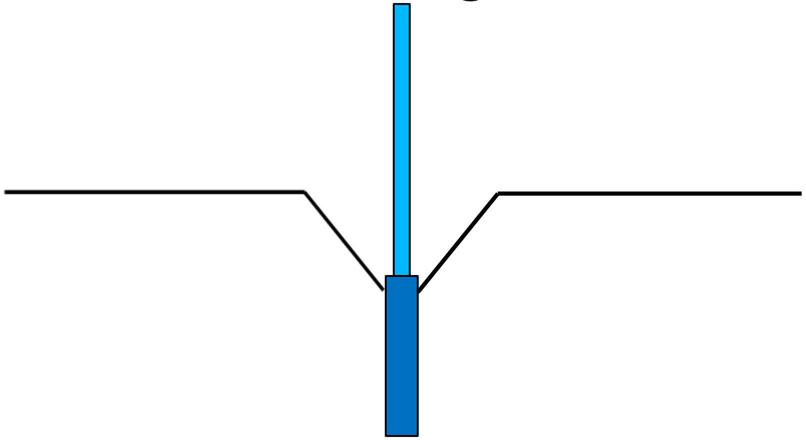
Minimal radials to resonators, Gull Wing, VOR = up to 7dB

Less Loss

“Resonator”



1/4λ Gull Wing radials



High Efficiency

Improved location for a vertical:

If possible, move for a clear path in the desired directions.

Adjacent to sloping ground lowers take-off angle ~1.1° per degree of slope in the direction of the slope.

Head to the beach and salt water!

Improved location for a vertical:

If possible, move for a clear path in the desired directions.

Adjacent to sloping ground lowers take-off angle ~1.1° per degree of slope in the direction of the slope.

Head to the beach and salt water!

Lower take-off angle

Fewer hops to the target area

Add <u>gain</u> to the antenna system:

3-4dB as a start

Higher ERP

Effective Radiated Power)

Add directivity to the antenna system:

More than 3-4dB

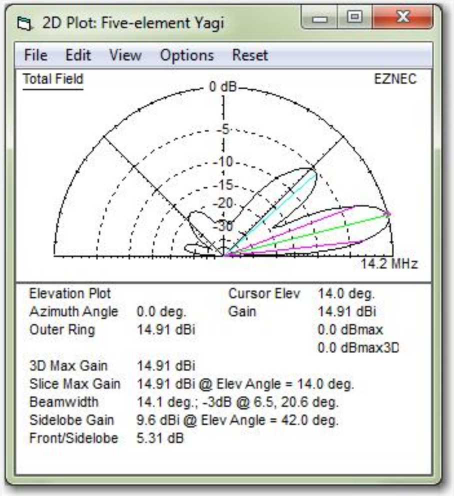
Higher ERP in the target direction

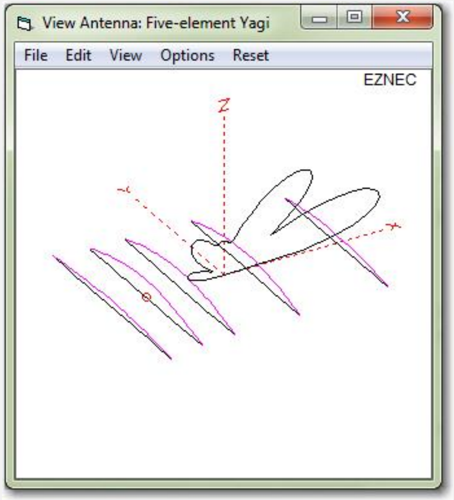
and hear better

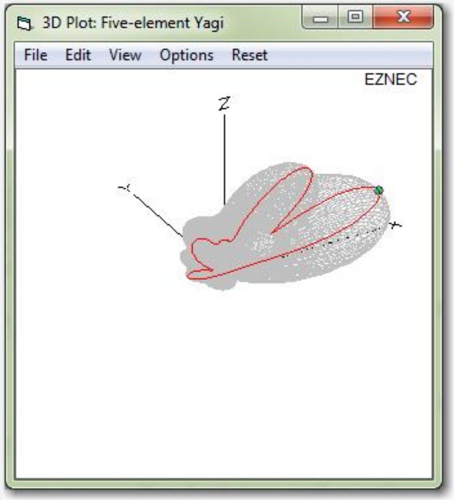

INTERSTATE
40
WEST
Albuqueque
INTERSTATE
40
EAST
Santa Rosa

Get Free

FREE - EZNEC Pro 2+ v. 7.0 is now available! - FREE







MMANA-GAL "Basic" v3.5.3.59 (Jan, 2022) (private use) still free download
Available in several languages

MMANA-GAL Pro-Version v3.3 (commercial use) is not free

Now we are equipped with modeling software, we can lay out a plan.

If our antenna is a common EFHW – can we make it better?

A detailed look at the popular EFHW

full size 1/2λ on 80 (130’)

at a height of 40’

These patterns show why some say their EFHW/G5RV is great and others say it isn’t.

https://myantennas.com/wp/ufaqs/how-the-efhw-8010-antenna-radiates-what-are-radiation-patterns-per-band/

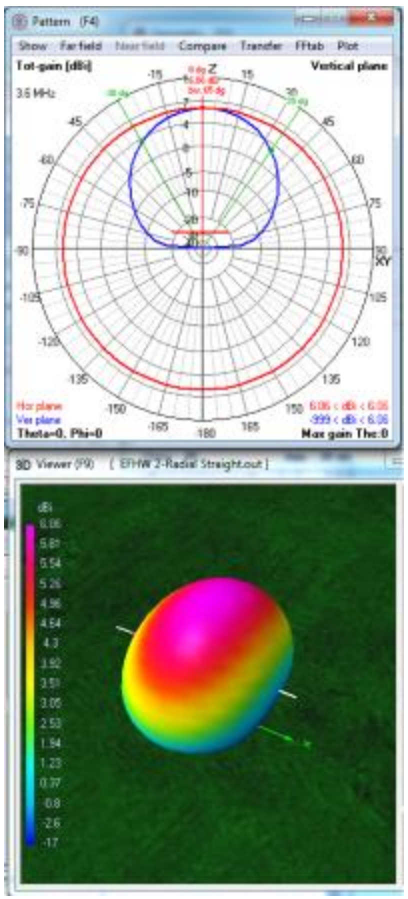
The radiation patterns of an EFHW-8010 antenna varies with frequency; Dick Reid, KK4OBI provides a great presentation of 3D and 2D patterns for EFHW-8010 antenna in various configurations.

As straight wire configuration
As inverted V configuration
As inverted L configuration
As sloping configuration

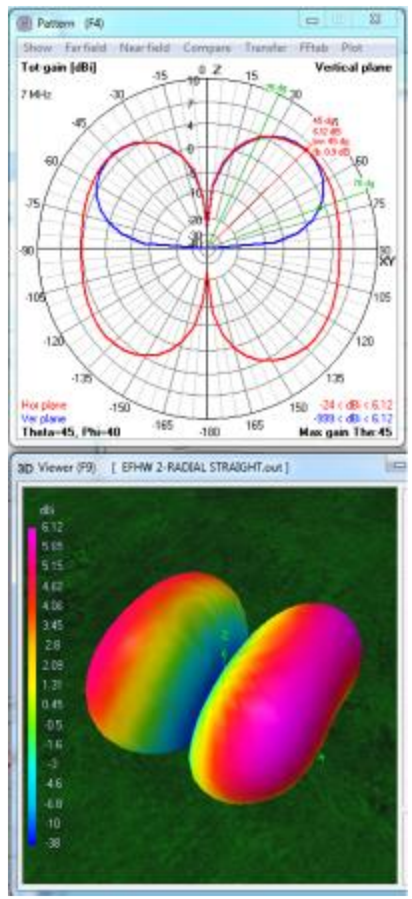
The following data are for the far field radiation patterns and 3D color views of *a **straight** End Fed Half Wave antenna at 40 feet* over "Real ground".

The direction of radiation is the Blue trace on the polar graphs. Horizontal is 90°. Up is 0°.
Red color indicates the stronger radiation on 3D views.

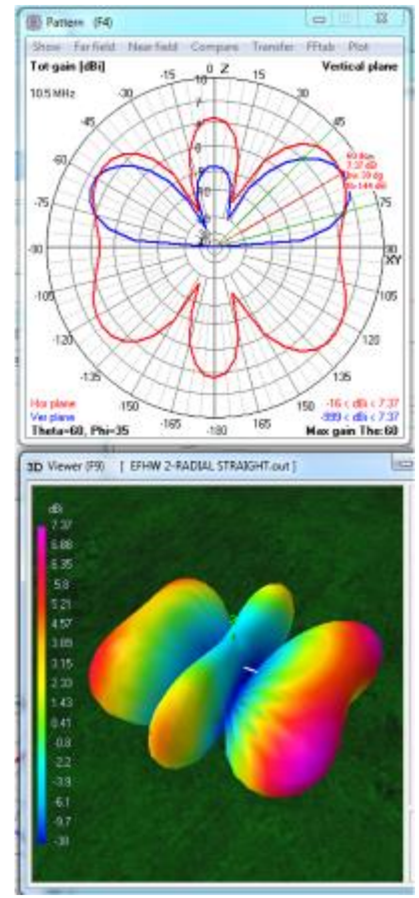
80m Fundamental – *full 1/2λ*
1 lobe 6.06 dBi at 0°



40m 2nd Harmonic
2 lobes 6.12 dBi at 50°



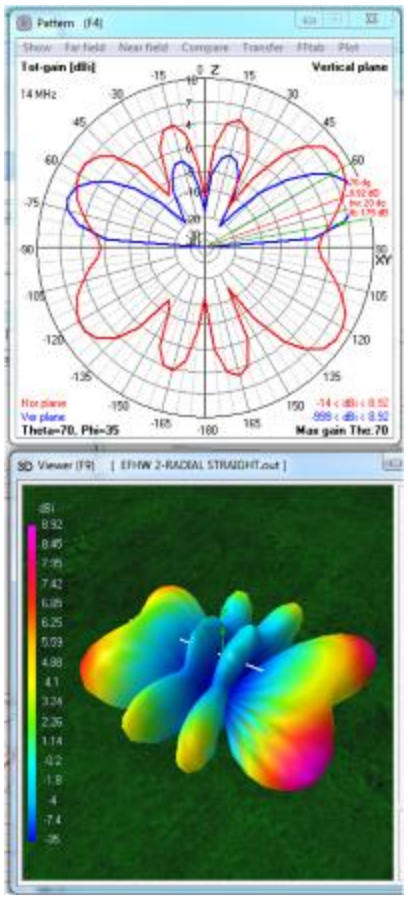
30m 3rd Harmonic
3 lobes 7.37 dBi at 60°



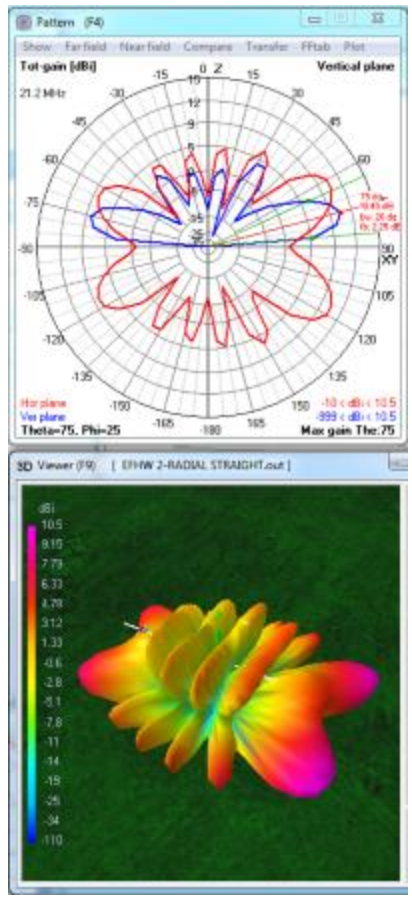
The following data are for the far field radiation patterns and 3D color views *of a **straight** End Fed Half Wave antenna at 40 feet* over "Real ground".

The direction of radiation is the Blue trace on the polar graphs. Horizontal is 90°. Up is 0°.
Red color indicates the stronger radiation on 3D views.

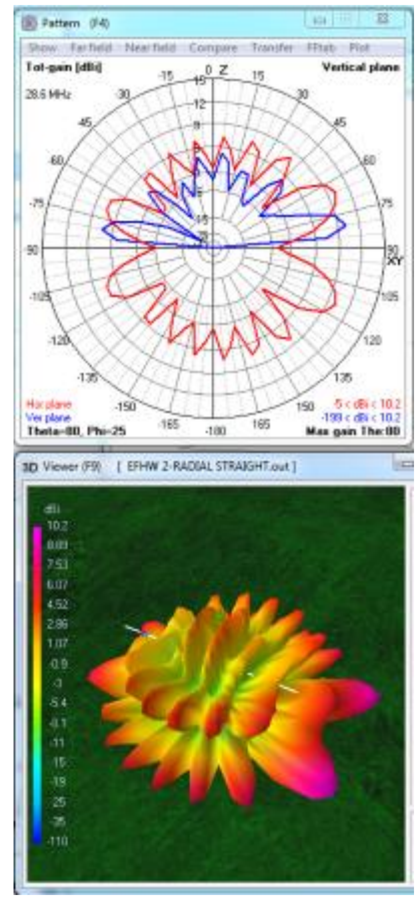
20 m 4th Harmonic
4 lobes 8.92 dBi at 70°



15m 6th Harmonic
6 lobes 10.5 dBi at 75°



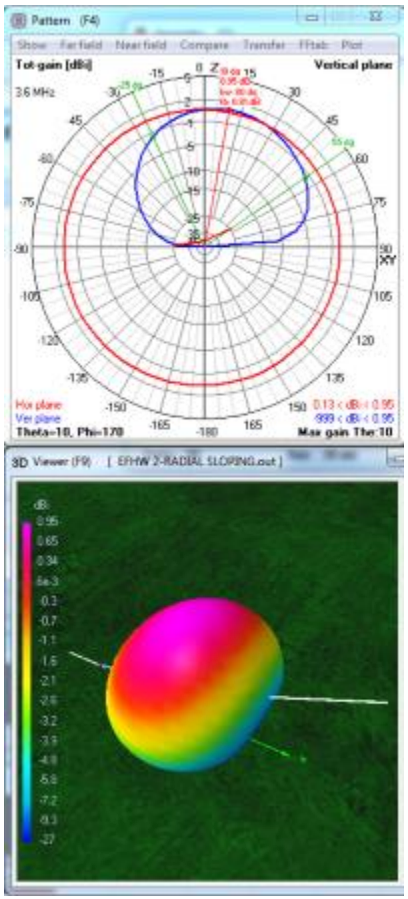
10m 8th Harmonic
8 lobes 10.2 dBi at 80°



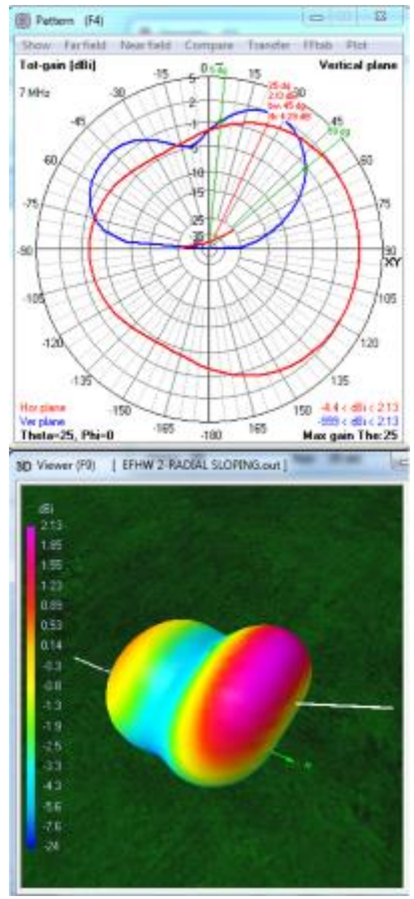
The following data are for the far field radiation patterns and 3D color views of a ***sloping*** *End Fed Half Wave antenna* with the feed point near ground and *curving upward to 40 feet at the far end.*

The direction of radiation is the Blue trace on the polar graphs. Horizontal is 90°. Up is 0°.
Red color indicates the stronger radiation on 3D views.

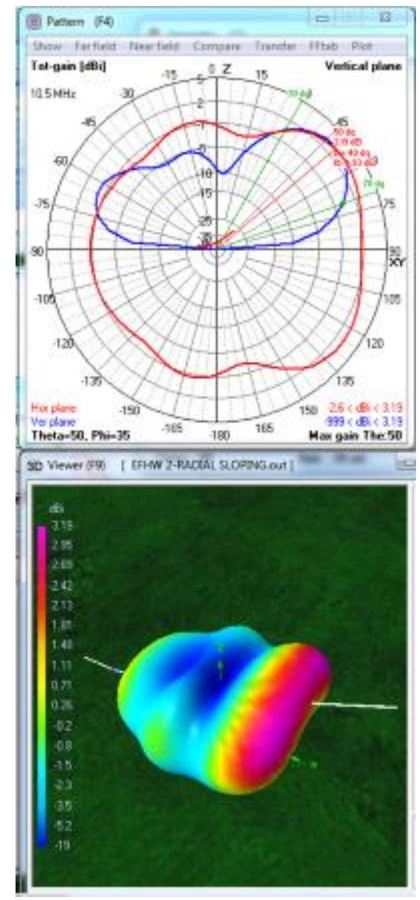
80m Fundamental – *full 1/2λ*
1 lobe 0.95 dBi at 10°



40m 2nd Harmonic
2 lobes 2.13 dBi at 26°



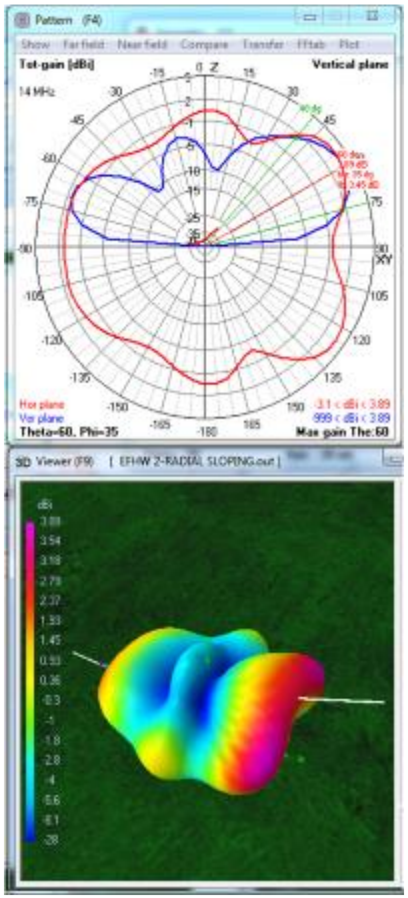
30m 3rd Harmonic
3 lobes 3.19 dBi at 50°



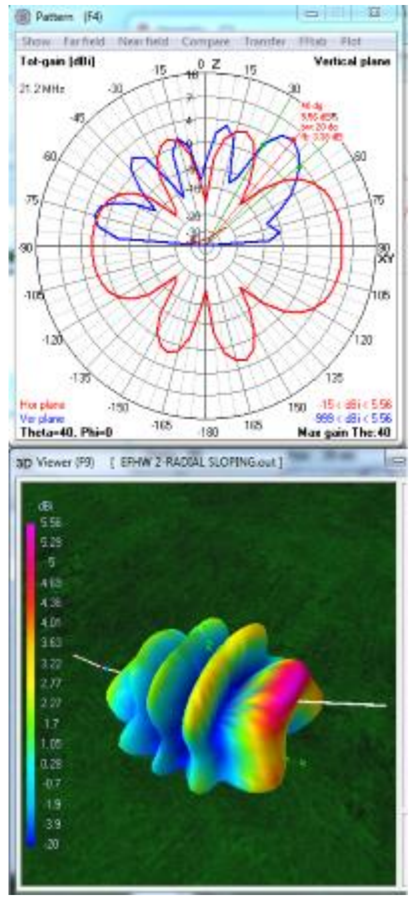
The following data are for the far field radiation patterns and 3D color views of a ***sloping*** *End Fed Half Wave antenna* with the feed point near ground and *curving upward to 40 feet at the far end.*

The direction of radiation is the Blue trace on the polar graphs. Horizontal is 90°. Up is 0°.
Red color indicates the stronger radiation on 3D views.

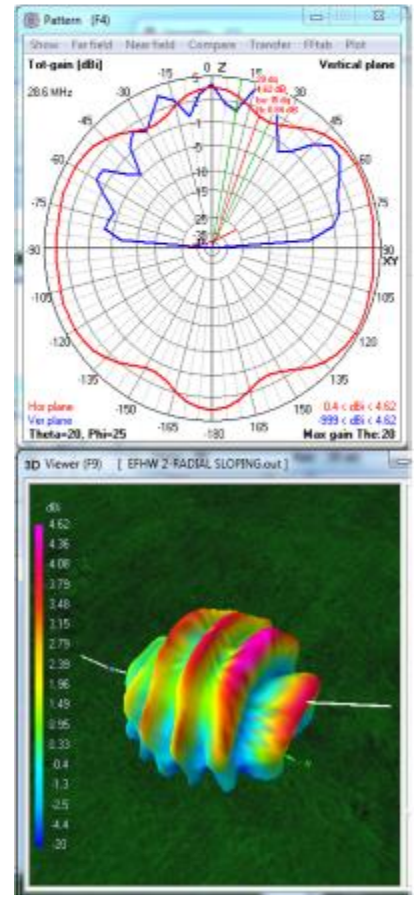
20 m 4th Harmonic
3.lobes 3.89 dBi at 60°



15m 6th Harmonic
6 lobes 5.56 dBi at 40°



10m 8th Harmonic
8 lobes 4.62 dBi at 20°



Issues with the EFHW are:
multi-band - the pattern changes per band - fairly unknown coverage to desired target zones

What to do?
__change the orientation based on the modeled patterns to favor the target zones
_____based on modeling, elevate or change the shape of the antenna to improve the patterns
_______consider shortening it (omit 80 mtrs) to help elevate

Can we get any gain?
__change the coax feed line if it is small (i.e. RG-58 or 8X to LMR-240UF)
___this will possibly *lower loss* in the feed system, which could be called “gain”

Issues with the EFHW are:
multi-band - the pattern changes per band - fairly unknown coverage to desired target zones

What to do?
__change the orientation based on the modeled patterns to favor the target zones
_____based on modeling, elevate or change the shape of the antenna to improve the patterns
_______consider shortening it (omit 80 mtrs) to help elevate

Can we get any gain?
__change the coax feed line if it is small (i.e. RG-58 or 8X to LMR-240UF)
___this will possibly *lower loss* in the feed system, which could be called "gain"

To
GET GAIN
need another element.

What if we change to a vertical?

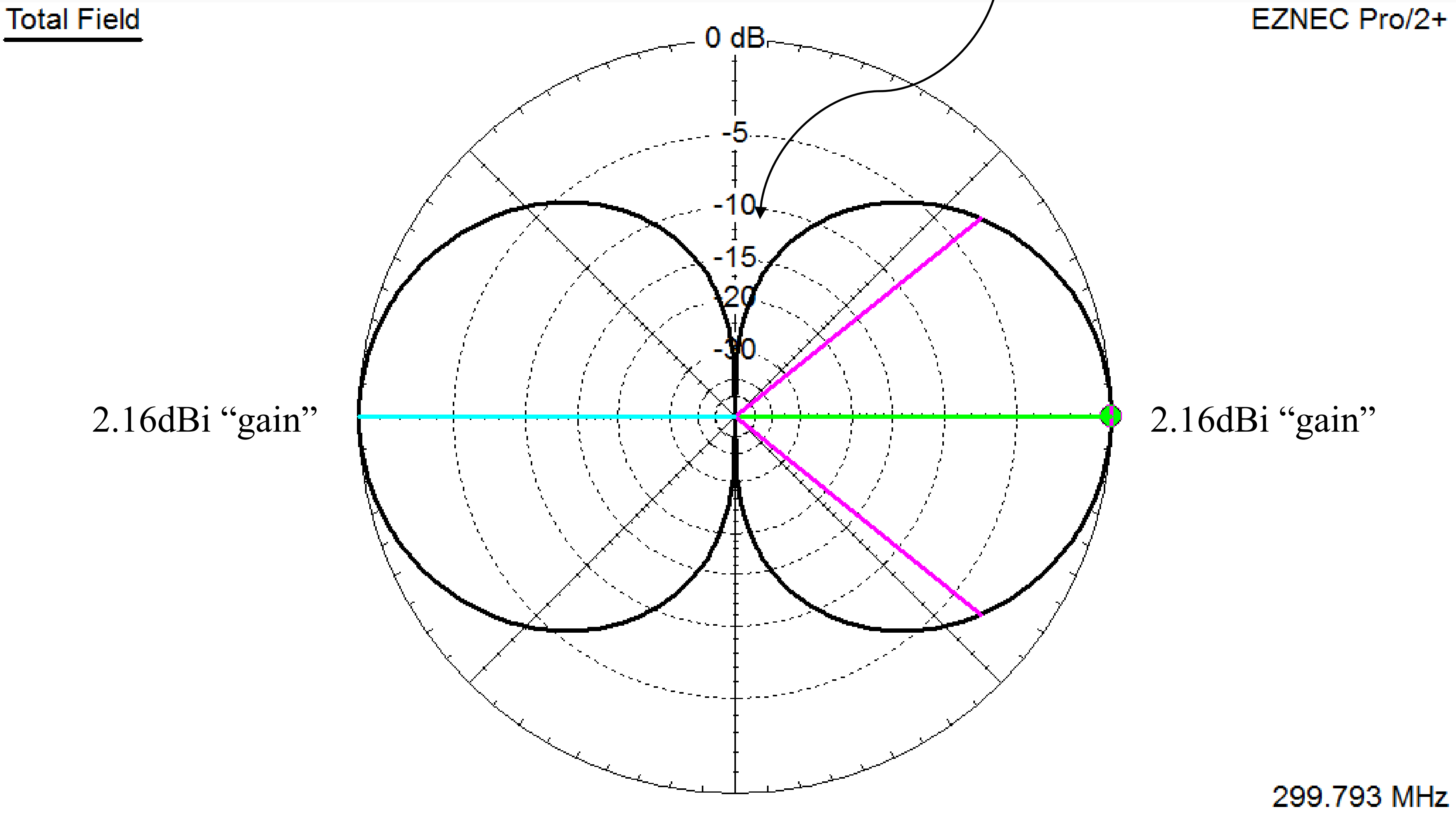
Anything meaningful happens?

Pattern

Where the energy is actually going,

just as on a dipole in free space

The 2.16dBi energy came from these side nulls

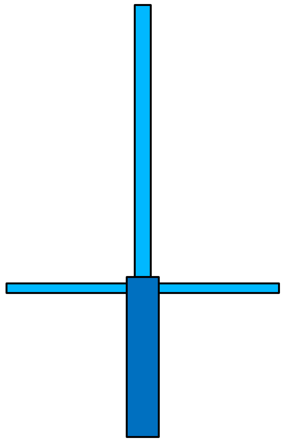


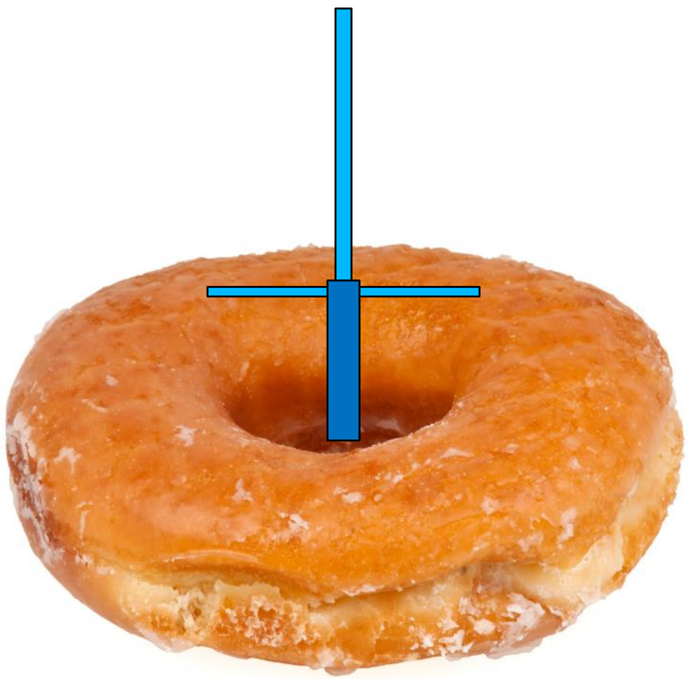
2.16dBi “gain”

2.16dBi “gain”

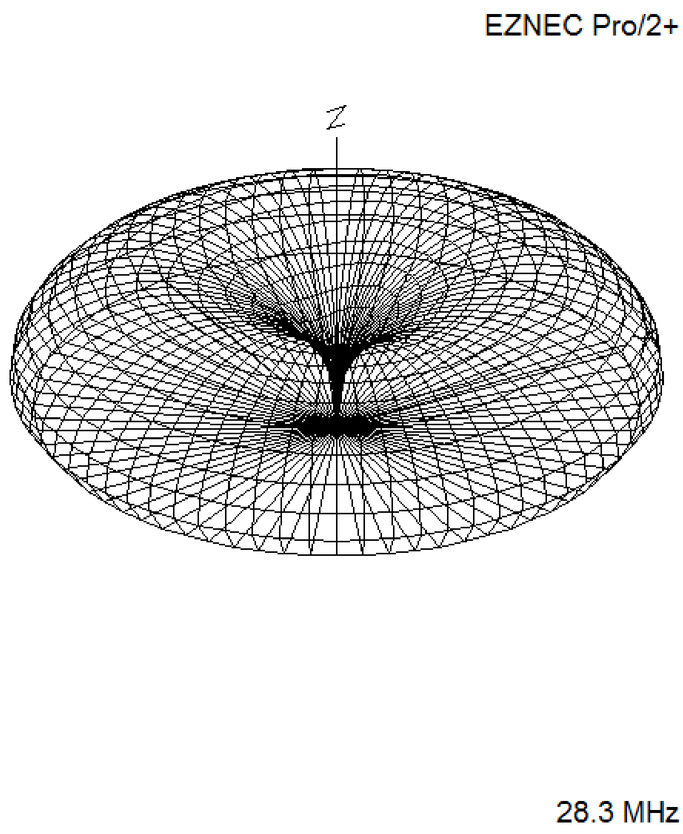
Single band vertical

Bravo design, no radials



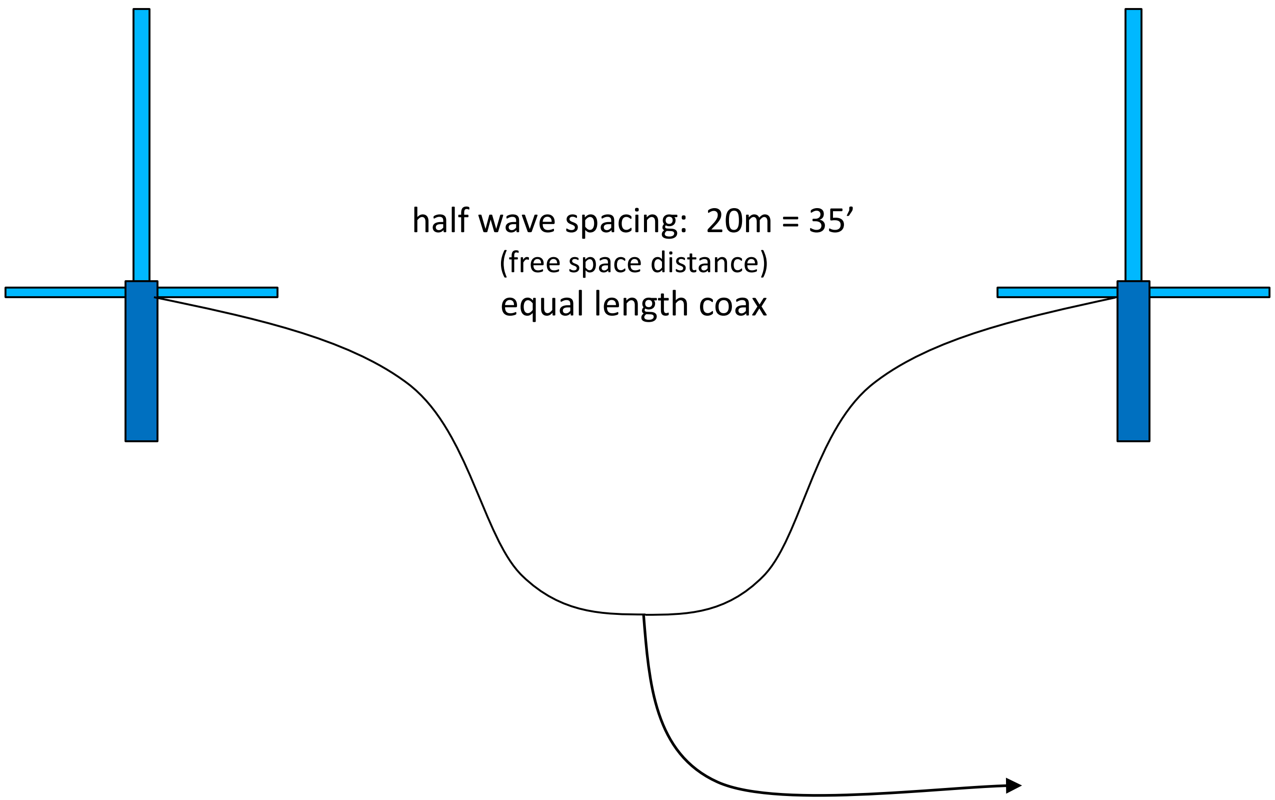


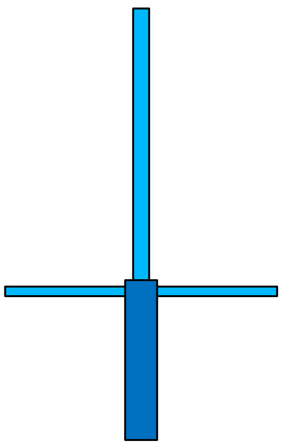
Expected pattern = getting energy to target zone.

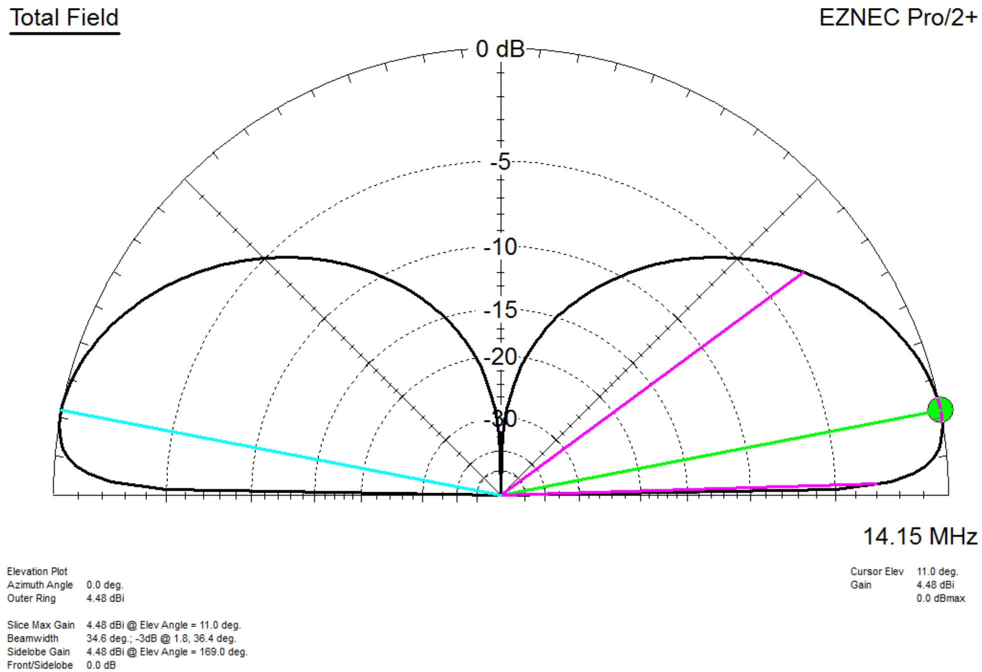


Single band vertical x 2

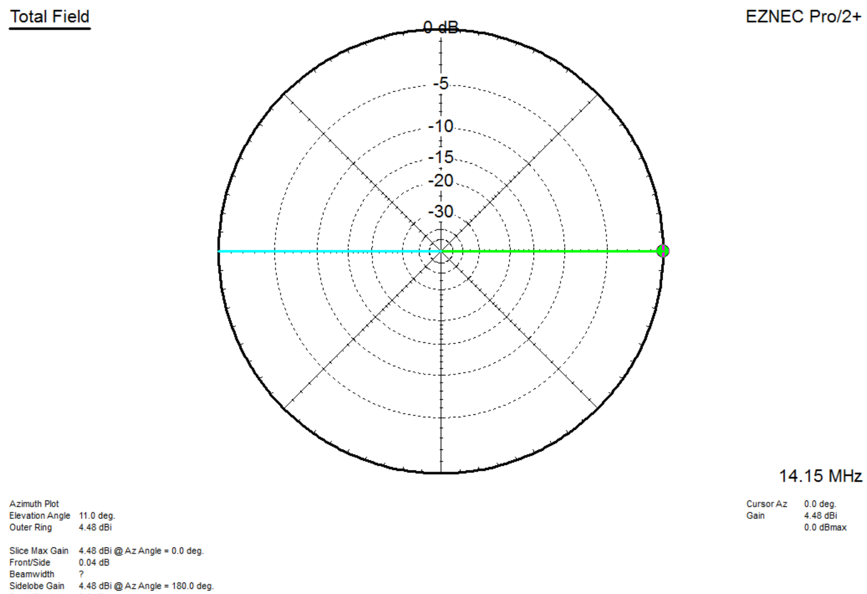
Bravo design, no radials







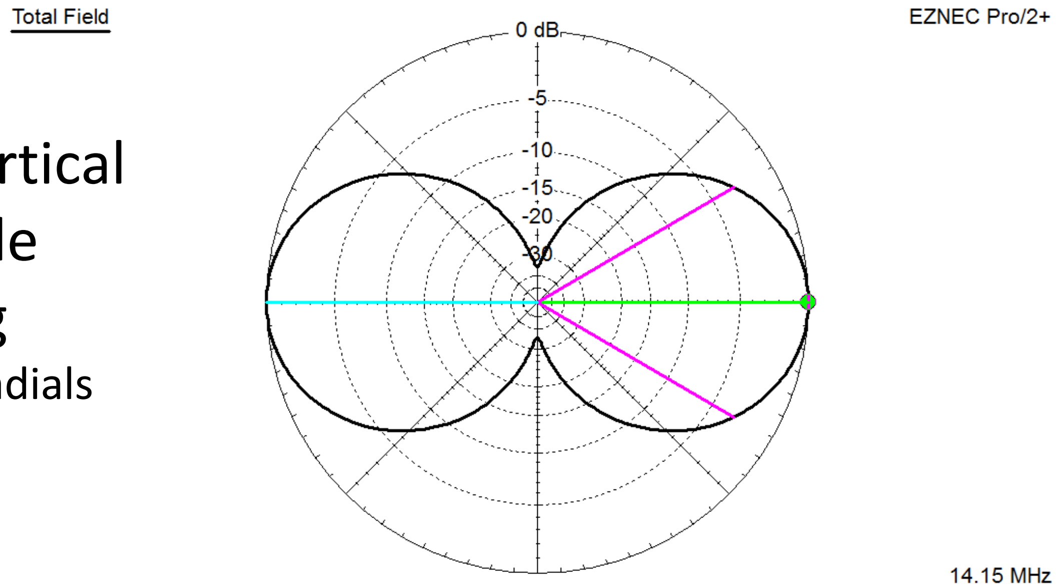
Total Field
EZNEC Pro/2+
0 dB
-5
-10
-15
-20
-30
14.15 MHz
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 4.48 dBi
Slice Max Gain 4.48 dBi @ Elev Angle = 11.0 deg.
Beamwidth 34.6 deg.; -3dB @ 1.8, 36.4 deg.
Sidelobe Gain 4.48 dBi @ Elev Angle = 169.0 deg.
Front/Sidelobe 0.0 dB
Cursor Elev 11.0 deg.
Gain 4.48 dBi
0.0 dBmax

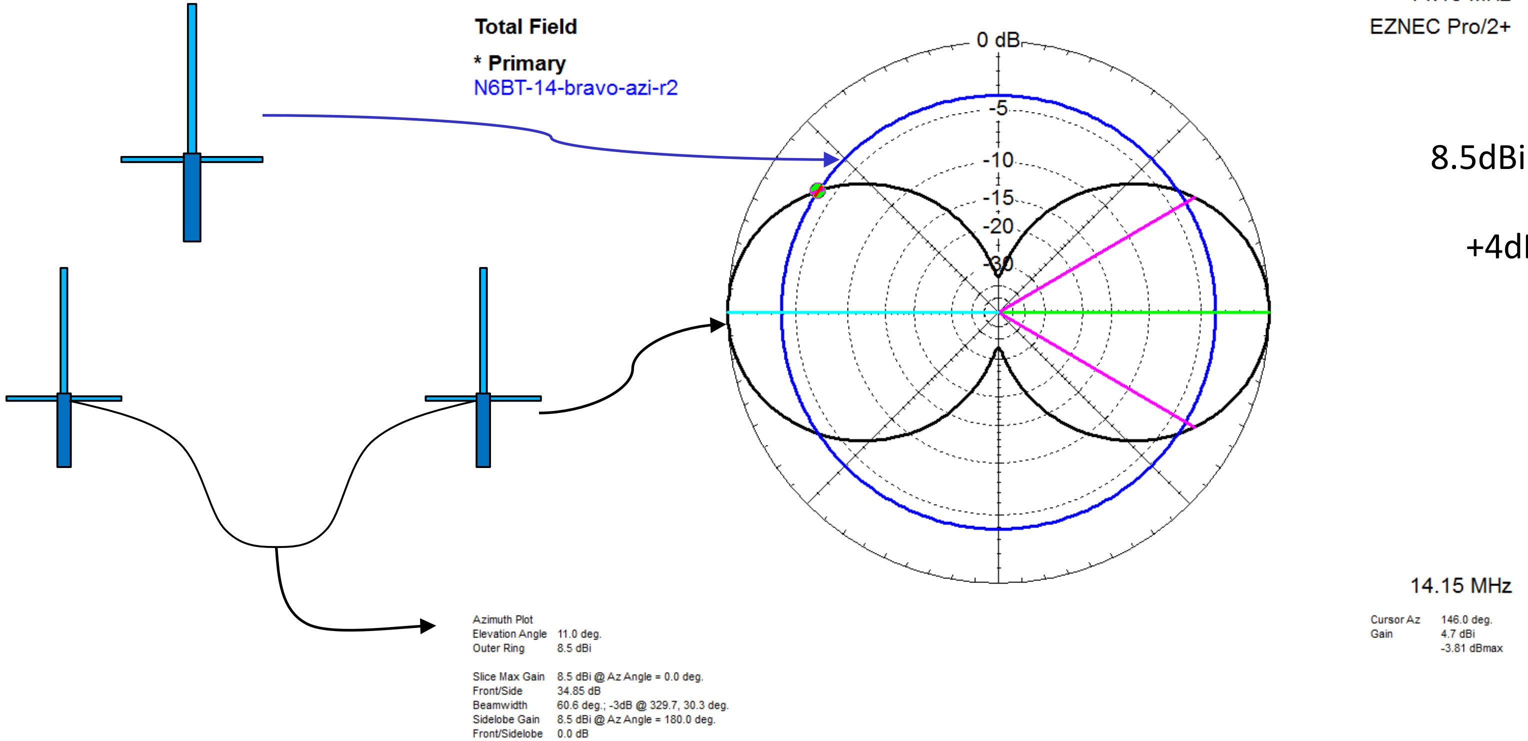


Total Field
EZNEC Pro/2+
0 dB
-5
-10
-15
-20
-30
14.15 MHz
Azimuth Plot
Elevation Angle 11.0 deg.
Outer Ring 4.48 dBi
Slice Max Gain 4.48 dBi @ Az Angle = 0.0 deg.
Front/Side 0.04 dB
Beamwidth ?
Sidelobe Gain 4.48 dBi @ Az Angle = 180.0 deg.
Front/Sidelobe 0.0 dB
Cursor Az 0.0 deg.
Gain 4.48 dBi
0.0 dBmax

20 mtr band vertical
2el broadside
35’ spacing

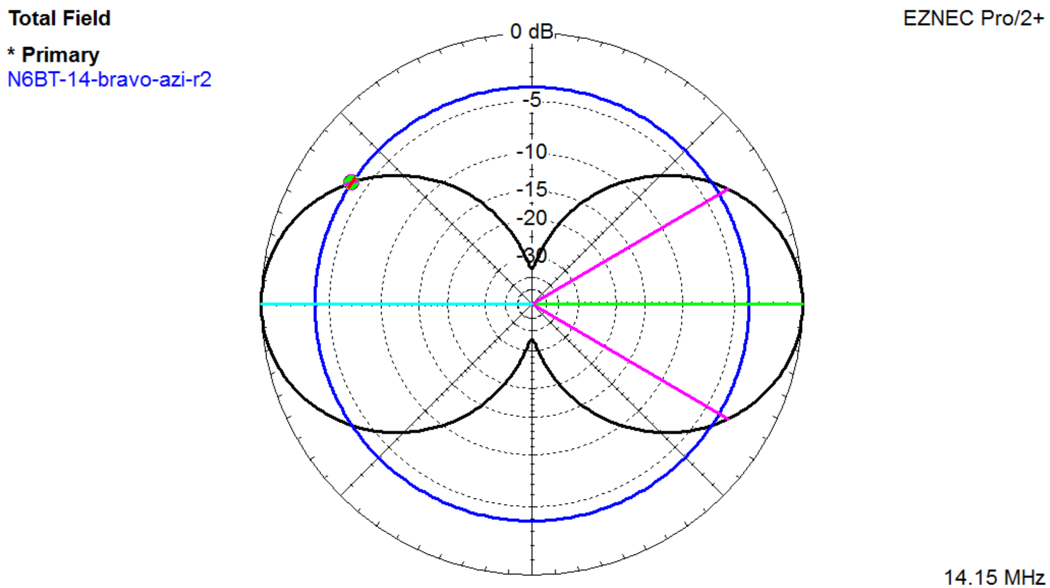
Bravo design, no radials

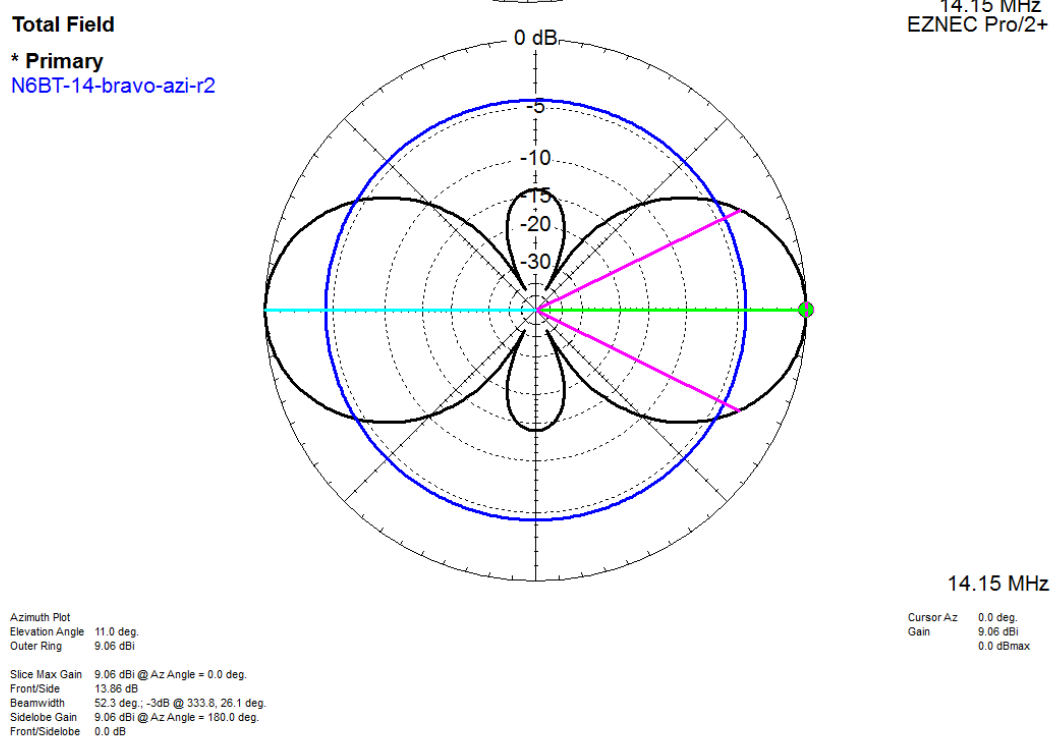


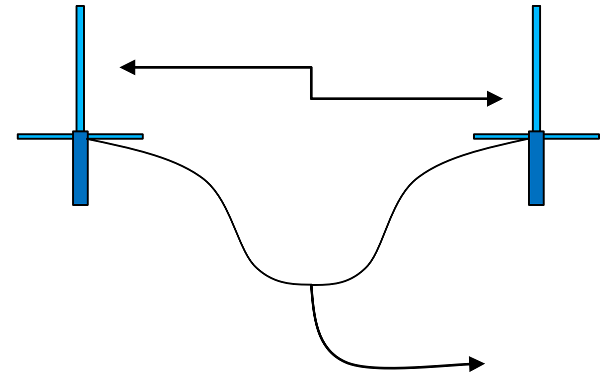


8.5dBi 61° beamwidth

+4dB over a single





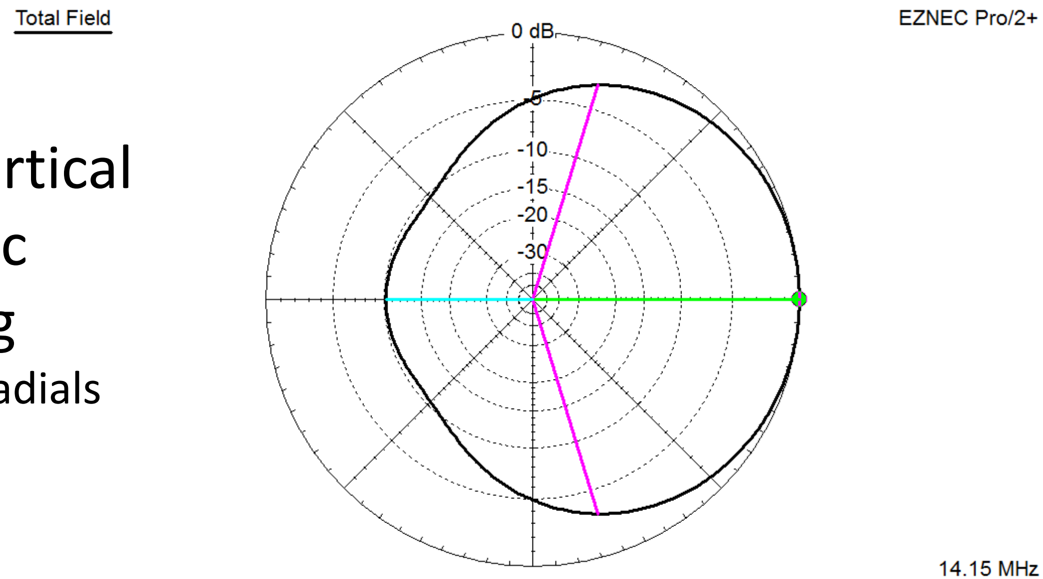


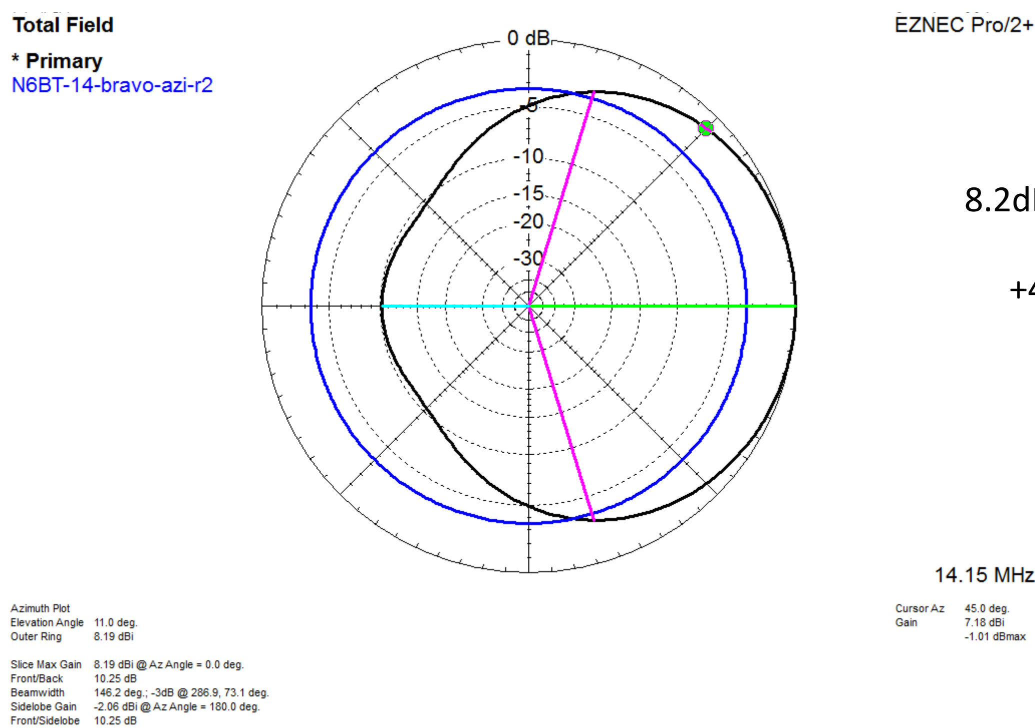
expanding spacing by 25%
9.1dBi 52° beamwidth
plus side lobes

+4.6dB over a single

20 mtr band vertical
2el parasitic
12' spacing

Bravo design, no radials





8.2dBi 146° beamwidth

+4dB over a single

This looks like a reasonable way to
Get Some
gain.

…but…

actually, I don’t need a vertical because
I have another tower.

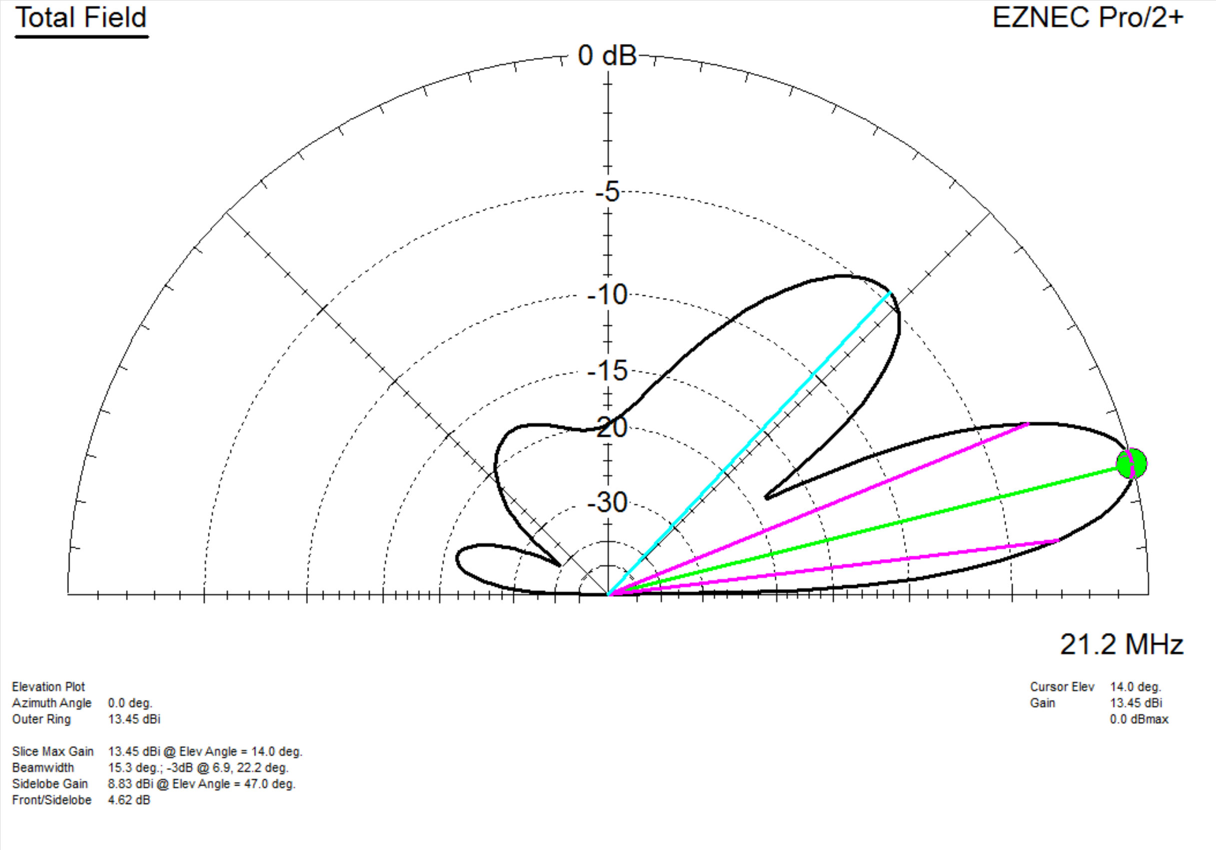
What can I make?

I need more on the high bands,
like 15 meters.

Maybe something not too large…

Perhaps a 4el 15 meter Yagi, (~18-20′ boom)
on a 44′ mast, or for my lightweight tower

Perhaps a 4el 15 meter Yagi, (~18-20' boom) on a 44' mast, or for my lightweight tower



13.45dBi @ 14°

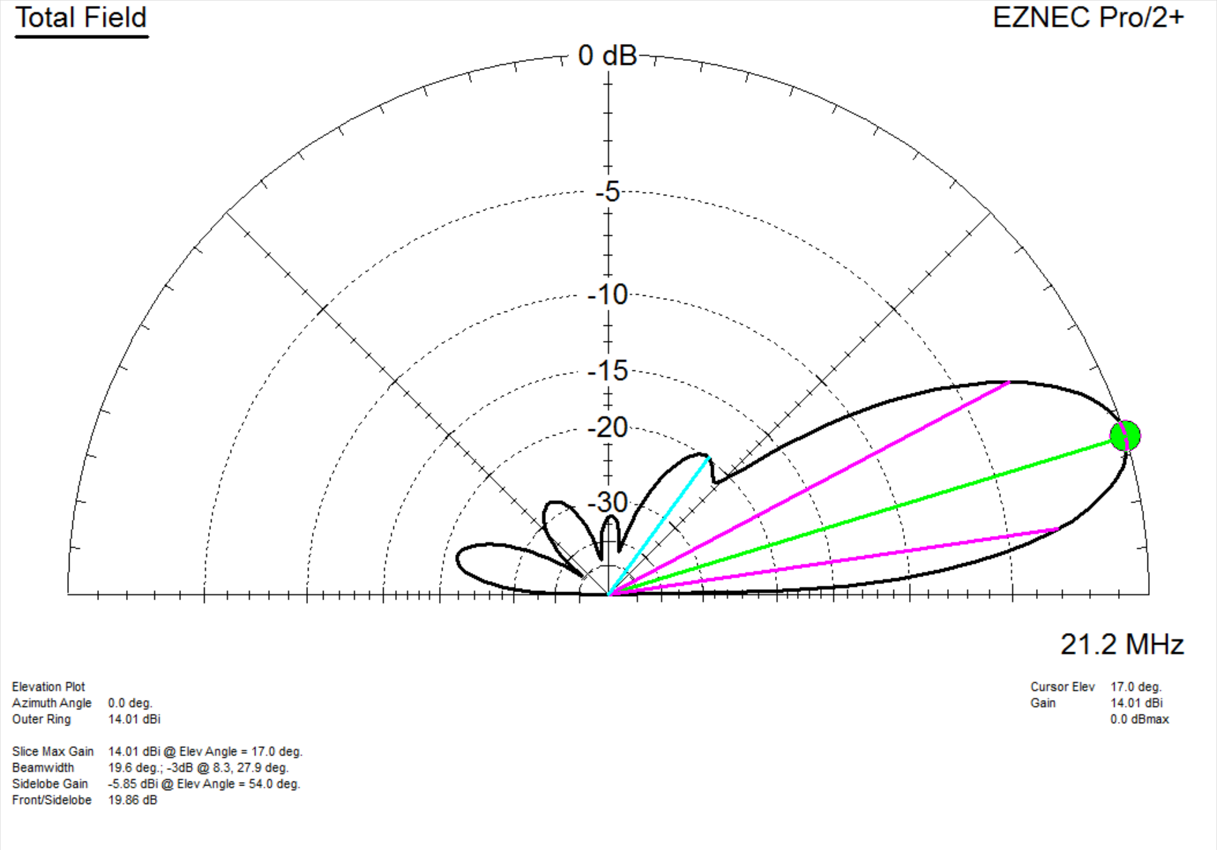
Nice design, but it still might be too much.

Boom’s too long, so
make a pair of 8’ booms instead.

Then, use the same (4) elements
and
design 2 ele 15 meter Yagis instead of the larger 4.

Put one at the top like before and the other farther down.

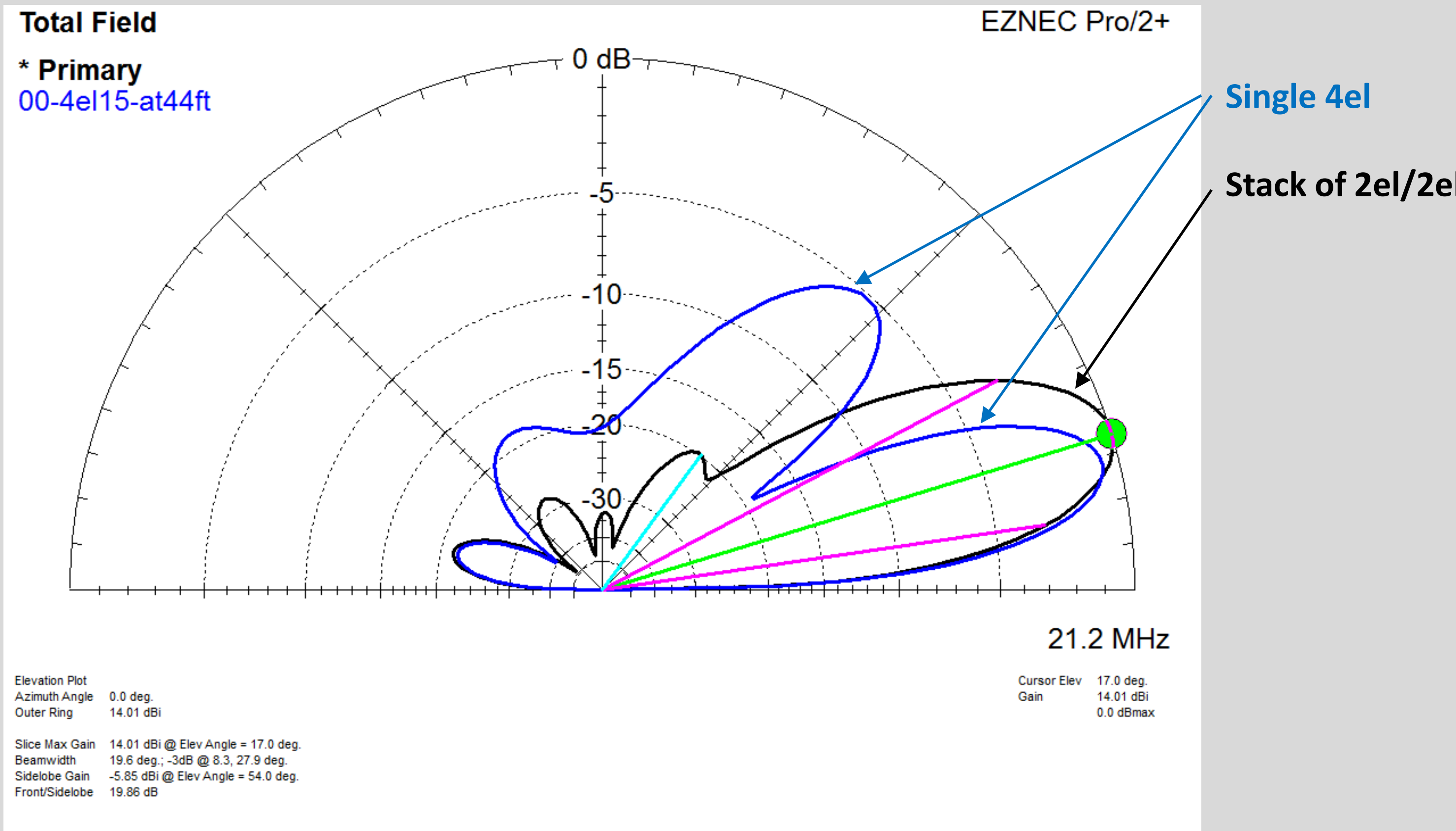
Let's model a stack of 8' boom 2el 15 meter Yagis and put them on the same mast



14.0 dBi @ 17°

8' booms – easy to handle and rotate
Less total boom length and same number of elements overall.

Improved pattern, more gain, less windload at the top.



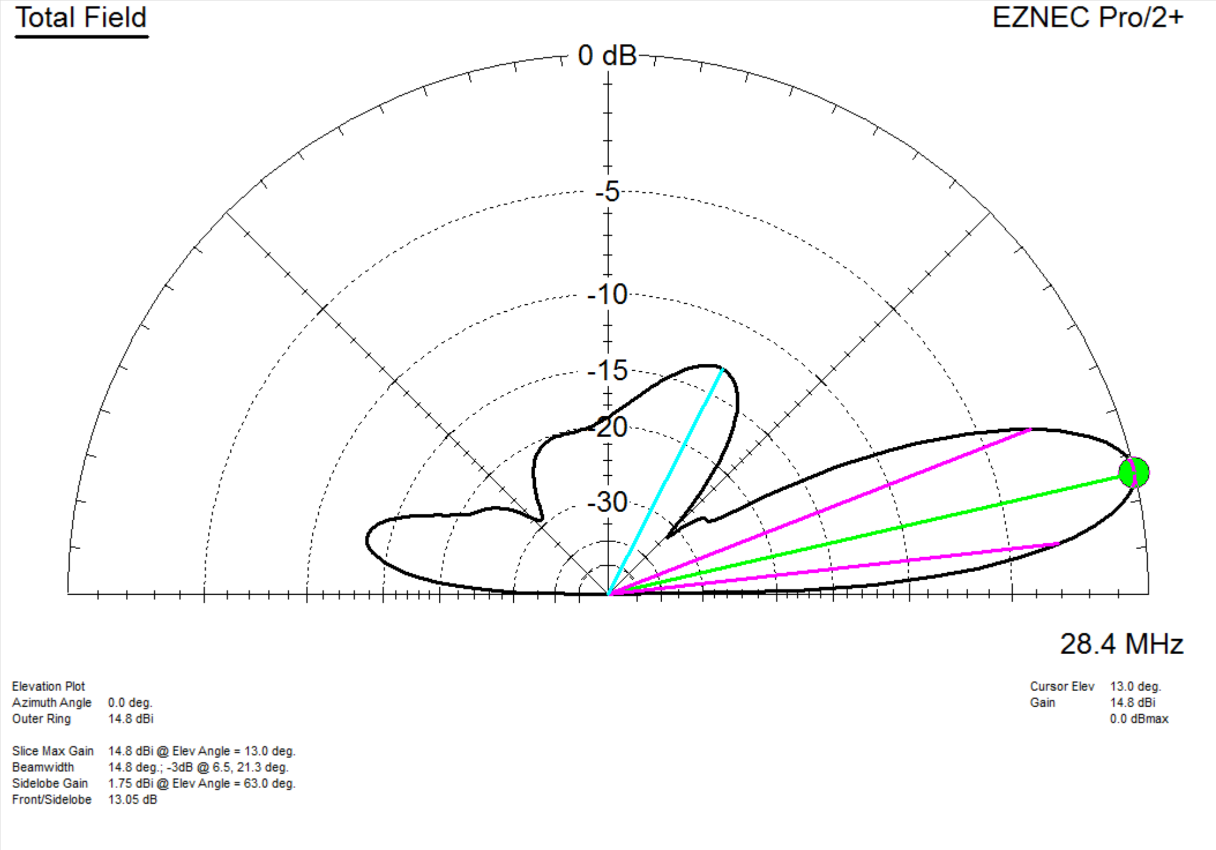
14.0 dBi @ 17°

8' booms – easy to handle and rotate
Less total boom length and same number of elements overall.

…wait…can we add 10 meters to these 2el 15 Yagis??

Why, YES, we can

Stacked 2 over 2 on 10 meters:



14.8 dBi @ 13°

AHA – stacked 10/15 with 8' booms

ONE FEED LINE

The phased verticals look like a reasonable project

and the Yagis too,

But

who makes these antennas?

You!

You!

…but with the high price of aluminum and other parts, this could be a pricey project.

Get Used

Repurpose

Make
NEW from OLD


CAUTION
HEATER FUEL

What antennas are likely to be around?

Quantities in the field?

---non-trapped are preferred---

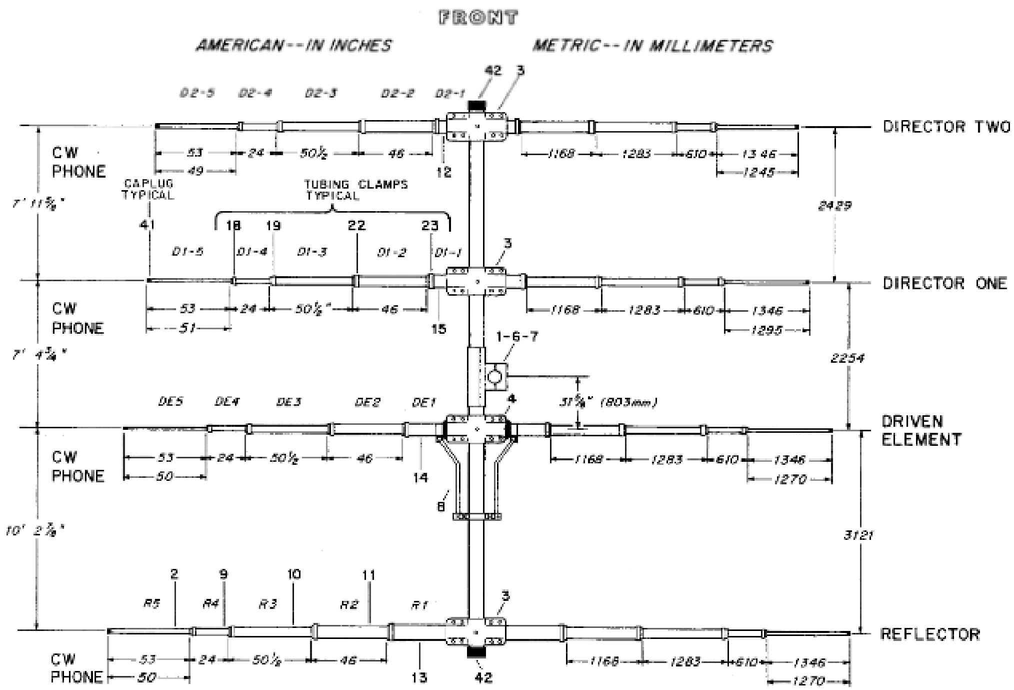
HyGain

CushCraft

Mosley

Force 12, Inc. >25,000 between 1991-2008
(99% HF)

HyGain 204ba 4el 20 meter monobander



Item No.	Description	Item No.	Description
1	Bracket, cast aluminum	12	D2-1, 1 1/4" x 16 3/4"
2	Element End Section, 7/16" x 55"	13	R-1, 1 1/4" x 44 1/2" w/insert
3	Element-to-Boom Bracket, #13 (small)	14	DE-1, 1 1/4" x 35" w/insert
4	Element-to-Boom Bracket, #14 (large)	15	D1-1, 1 1/4" x 21" w/insert
6	Boom-to-Bracket Clamp	18	Clamp, #4 Tubing
7	Casting-to-Boom Bracket	19	Clamp, #6 Tubing
8	Beta Rod, 1/4" x 30"	22	Clamp, #10 Tubing
9	Element Section 4, 5/8" x 26"	23	Clamp, #16 Tubing
10	Element Section 3, 7/8" x 55"	41	Caplug, 7/16", black
11	Element Section 2, 1 1/8" x 48"	42	Caplug, 2", black

Figure 7
Plan View of Antenna

24' of 2" boom
(4) full size 20 meter elements
(one split driver)
(4) Element brackets
(1) Mounting bracket assembly
(1) hairpin/beta match

~160' element tube, some swaged
Element compression clamps
Mounting hardware

HyGain Explorer 14 tribander

General Description

The Hy-Gain Explorer 14 is a very unique 4-element, three band beam antenna designed for broadband, high performance, high efficiency operation on the Amateur 10, 15, and 20 meter bands. The boom length of 14 feet 11/2 inches (4.17 m) and a longest element of 31 feet 6 inches (9.6 m) combine for a modest 17 foot 3 inch turning radius, small enough for most city lots. Broadbanding is accomplished through the use of a monoband reflector on 10 meters, a duoband reflector on 15 and 20 meters and a very unique driven element system called the Para-Sleeve

Stainless steel hardware and clamps are used on all electrical and mechanical connections. Hy-Gain's 50 ohm BN-86 balun and new Beta Multi-Match are supplied. Add-on kits for a 30 or 40 meter driven element are available as option QK-710. The antenna is designed to fit masts from 2" to 2 1/2" in diameter and can be rotated with Hy-Gain's CD-4511 or Ham IV rotators.

Driven Element

The Explorer 14 utilizes a new concept in driven element design, called the Para-Sleeve System (Patent No. 4,604,628). Basically, the design consists of on *open-sleeve dipole that has been optimized for maximum bandwidth and directivity within a Yagi-Uda configuration of parasitic elements. The open-sleeve dipole has evolved from the coaxial sleeve dipole; however, it is much easier to tune and exhibits less wind loading. The ParaSleeve System consist of a trapped driven element for 15 and 20 meters, electrically connected to the balun and Beta-Match; and a set of two parallel sleeve element for 10 meters.

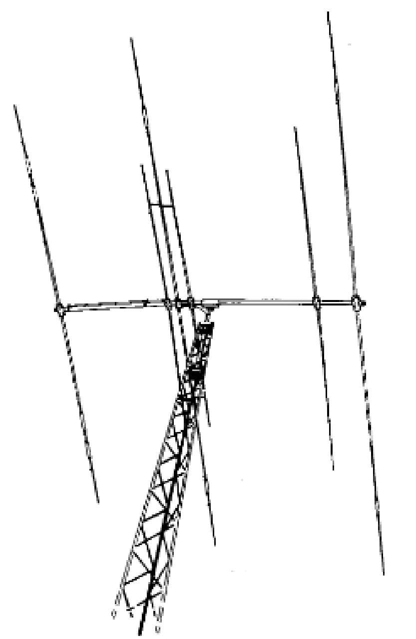
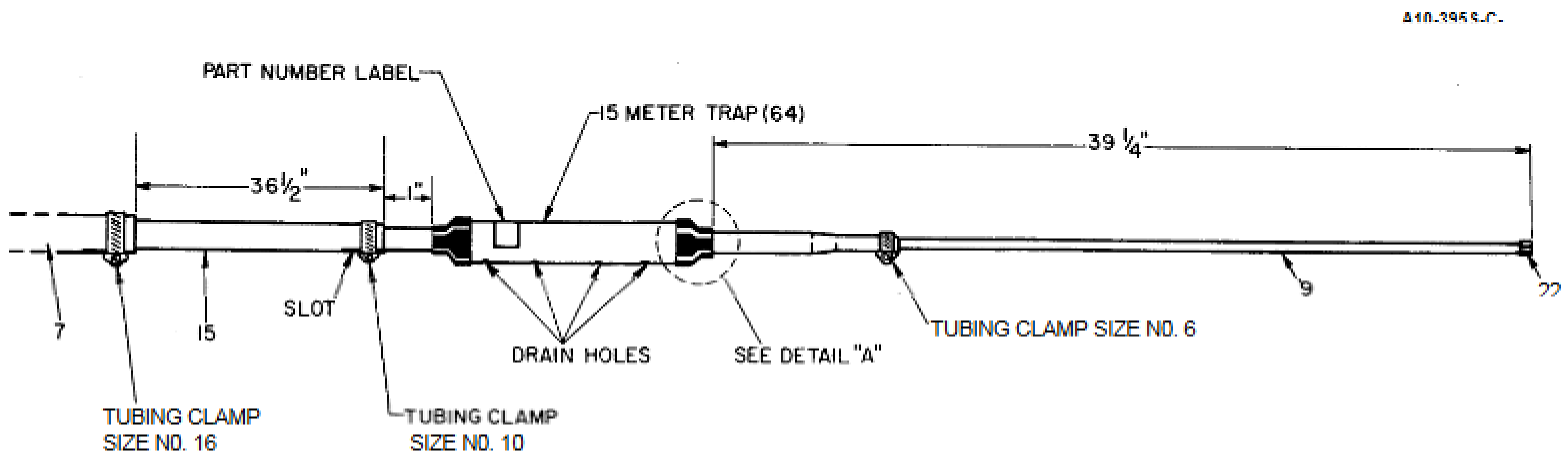


Figure 1
Overall View

This driven element system allows half element lengths of 0.209 wavelength on 20 meters, 0.242 wavelengths on 15 meters and 0.241 wavelength on 10 meters.

* For more information on the open-sleeve dipole, see H.E. King and J.L. Wong, "An Experimental Study of a Balun-Fed Open-Sleeve Dipole in Front of a Metallic Reflector", IEEE Trans. Antennas Propagation, Vol. AP-20,201-204, March 1972. Also see: Roger Cox, "The Open-Sleeve Antenna", CQ Magazine, Vol. 39,



N
00

Center Driven Element

Select the DE-1 section (11/4" x 83") and a large driven element insulator (see Figure 4). Slip the insulator on the unslotted end of the DE-1 section, completely.

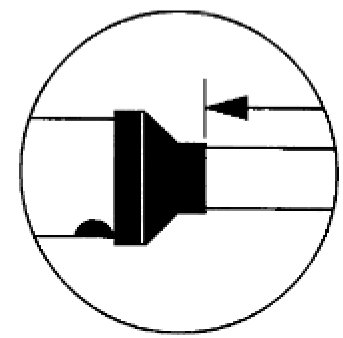
Install a #16 tubing clamp onto the slotted end of the DE-1 and insert the unslotted end of the DE-2 (1 1/8" x 42") to the dimension shown in Figure 9. Tighten the tubing clamp securely and recheck the DE-2 dimension.

Assemble the remainder of the center driven element in the same manner using dimensions from Figure 9. Use 15 meter trap Part Number 878637 in this assembly

Item No.	Description
7	Tube Assembly, aluminum, 11/4" x 83", R1, DE-1

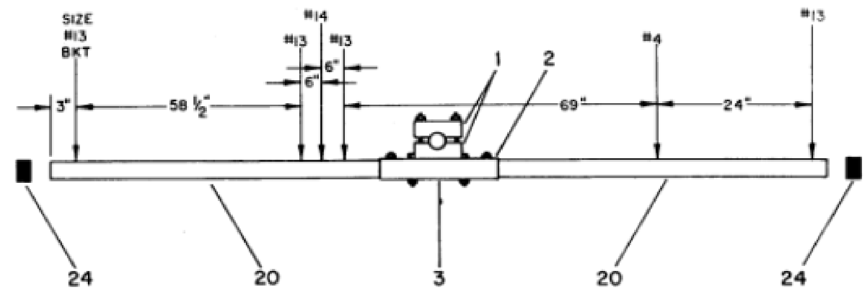
NOTE: ON ALL TRAPS MAKE SURE ALL DRAIN HOLES ARE FACING THE GROUND, ALL LABELED ENDS ARE TOWARDS THE BOOM AND ALL INSULATORS AND TRAP CAPS ARE FIRMLY SEATED. ALSO ON ALL TUBING ATTACHED TO TRAPS, MAKE SURE ALL SLOTS ARE FACING THE GROUND AND THE SMALL DRAIN HOLES ARE ALIGNED WITH THE SLOTS.

Figure
Center Driven



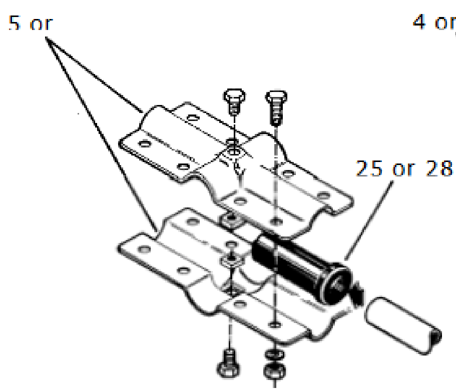
Dimensions Measured as

Detail A Trap Detail - Measuring Point

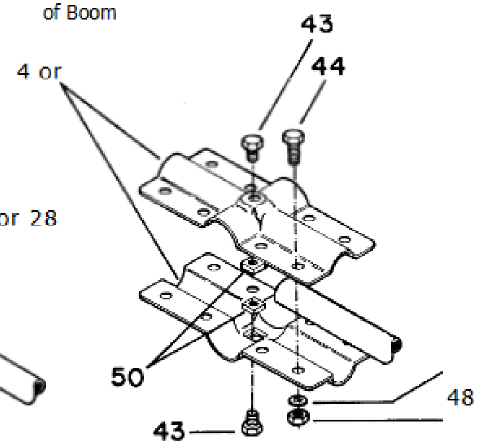


Item No.	Description	Item No.	Description
1	Bracket, Cast Aluminum	20	Tube, aluminum, 2"x 83
2	Bracket, Casting-to-Boom	24	Caplug, 2", black
3	Clamp, Boom-to-Bracket		

Figure 3 Assembly of Boom



Driven/Sleeve Detail



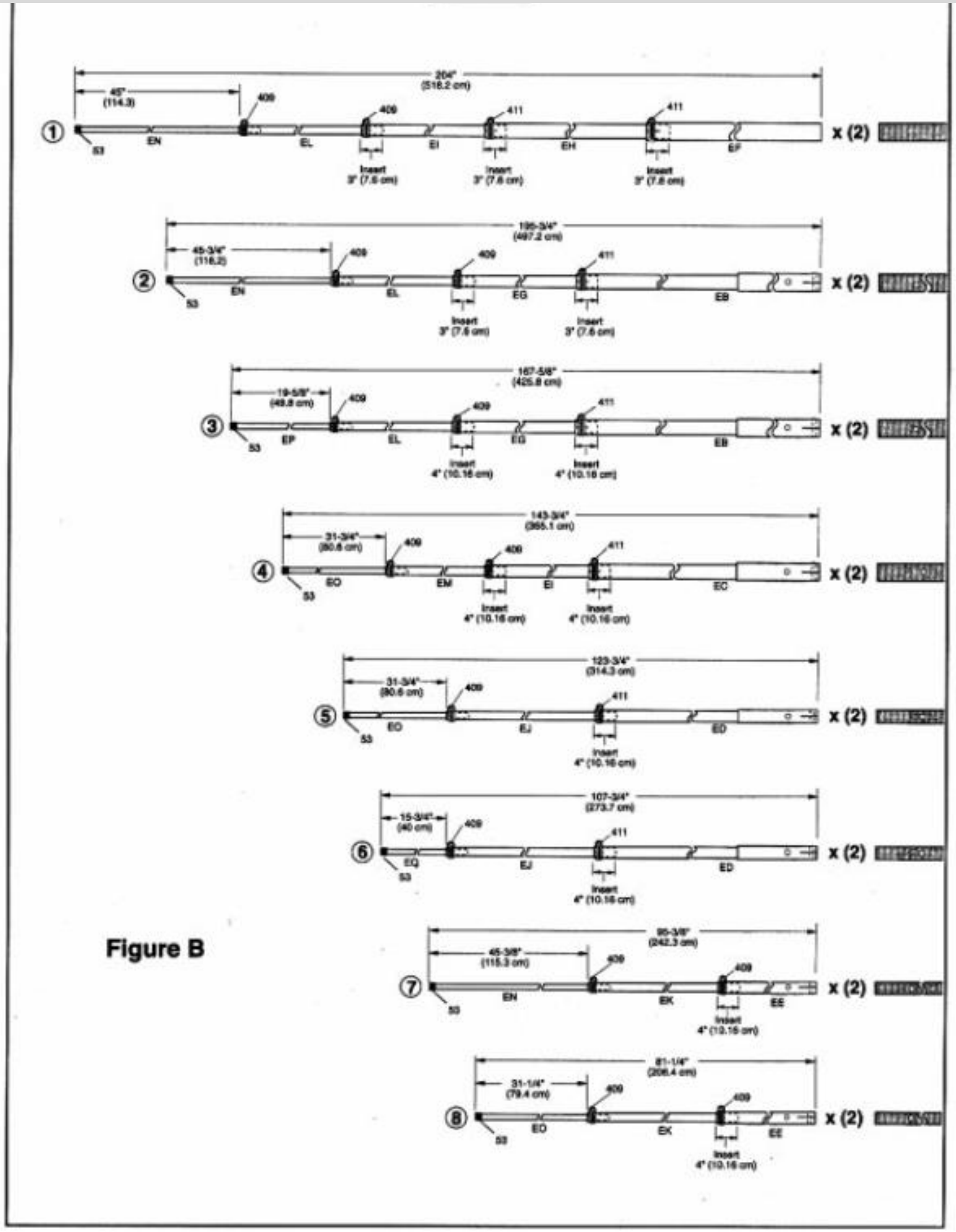
Reflector/Director Detail

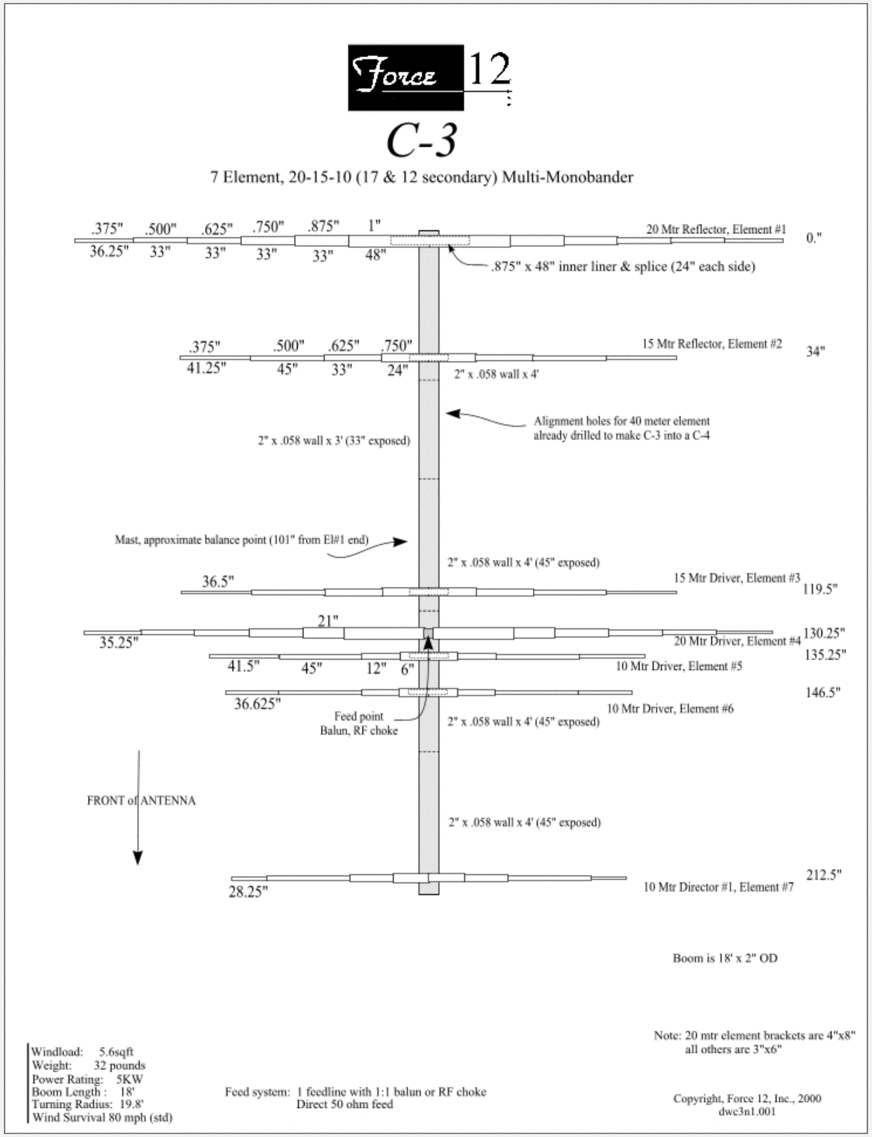
NOTE: The #4, # 13 and # 14 brackets use the same size bolts, lockwashers and nuts - in identical locations.

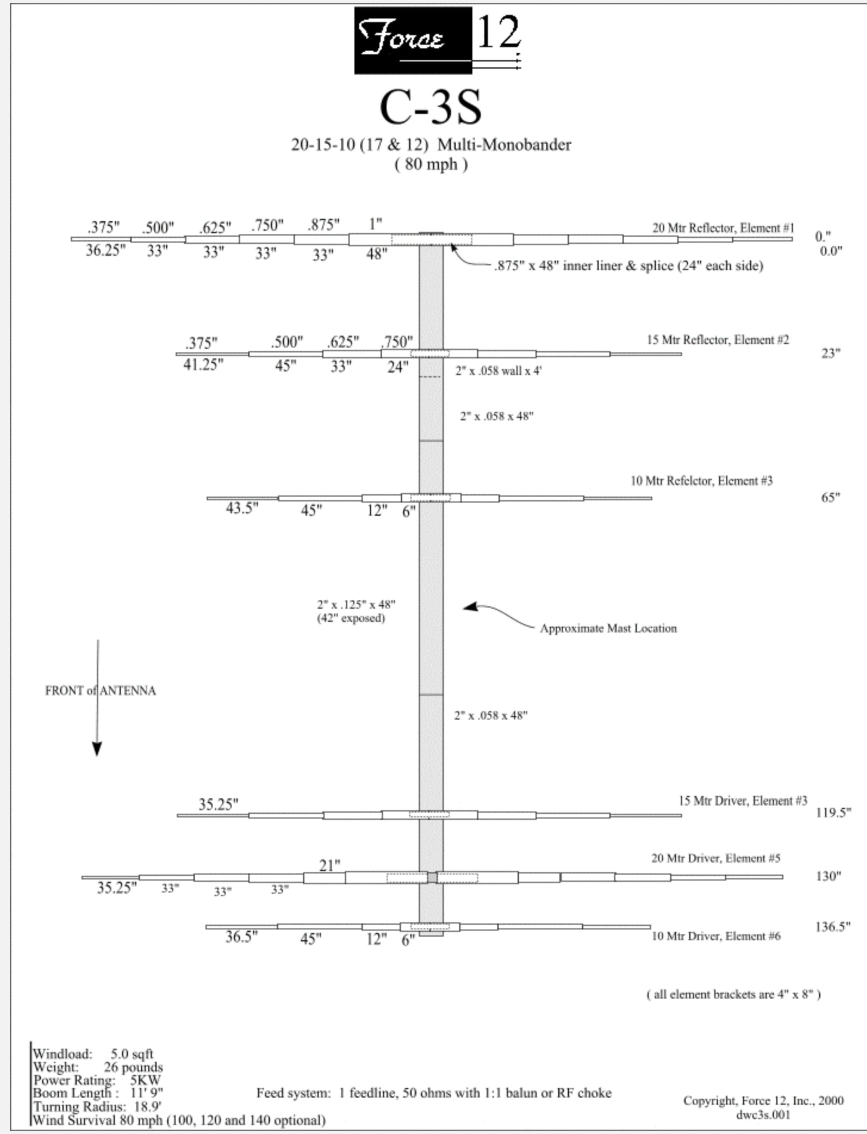
Item No.	Description	Item No.	Description
4	Bracket, Element-to-Boom, #4	43	Bolt, hex head, 1/4"-20 x 3/8", stainless
5	Bracket, Element-to-Boom, #13	44	Bolt, hex head, 1/4"-20 x 3/4", stainless
6	Bracket, Element-to-Boom, #14	48	Lockwasher, internal, 1/4", stainless steel
25	Insulator, Front & Rear Sleeves, 5/8" I.D.	49	Nut, hex, 1/4"-20, stainless steel
28	Insulator, Driven Element, 11/4" I.D.	50	Nut, square, 1/4"-20, stainless steel

Figure 4
Element-To-Boom Brackets

CushCraft LPDA element example



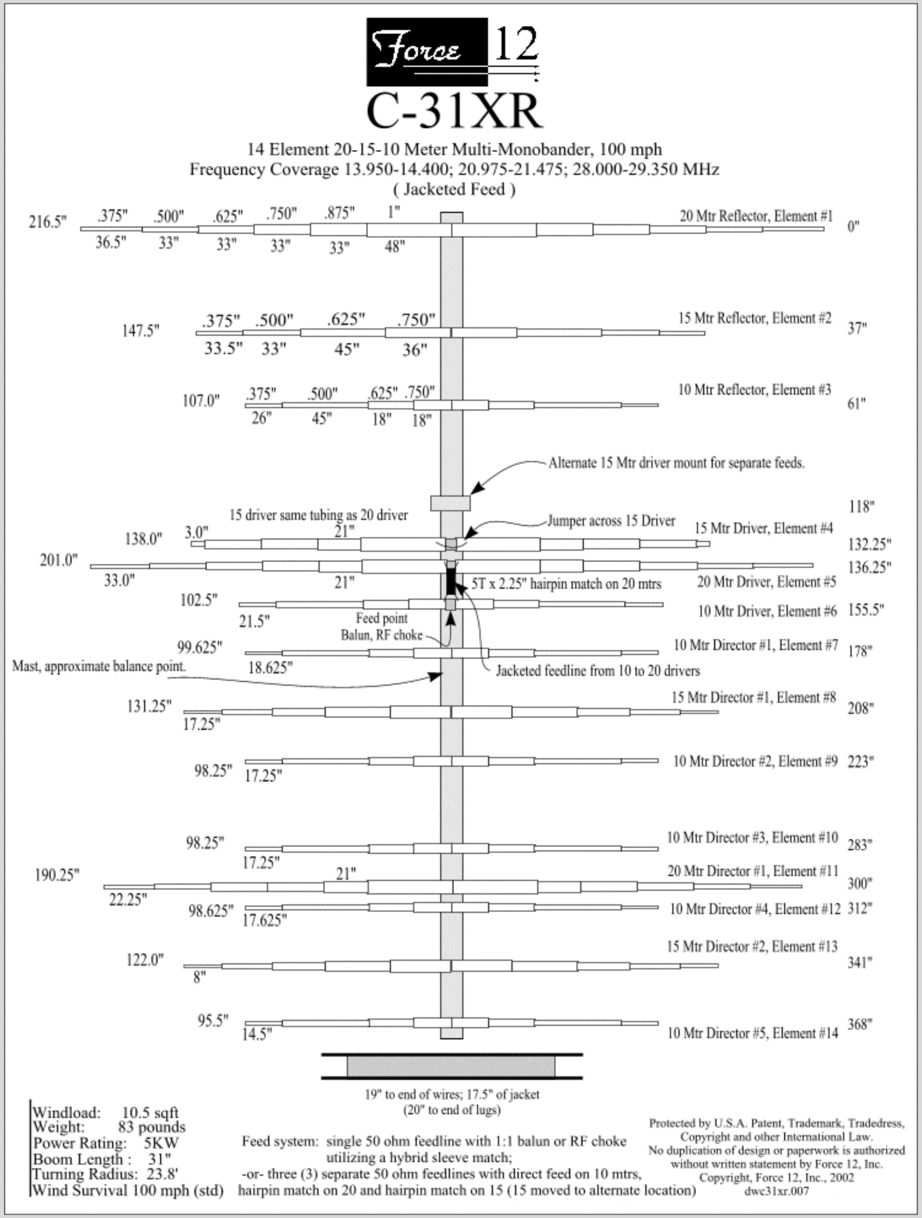

Force 12
C-3
7 Element, 20-15-10 (17 & 12 secondary) Multi-Monobander
.375" .500" .625" .750" .875" 1"
36.25" 33" 33" 33" 33" 48"
20 Mtr Reflector, Element #1
0."
.875" x 48" inner liner & splice (24" each side)
.375" .500" .625" .750"
41.25" 45" 33" 24"
15 Mtr Reflector, Element #2
34"
2" x .058 wall x 4'
Alignment holes for 40 meter element
already drilled to make C-3 into a C-4
2" x .058 wall x 3' (33" exposed)
Mast, approximate balance point (101" from El#1 end)
2" x .058 wall x 4' (45" exposed)
36.5"
15 Mtr Driver, Element #3
119.5"
21"
35.25"
20 Mtr Driver, Element #4
130.25"
41.5" 45" 12" 6"
10 Mtr Driver, Element #5
135.25"
36.625"
146.5"
10 Mtr Driver, Element #6
Feed point
Balun, RF choke
2" x .058 wall x 4' (45" exposed)
FRONT of ANTENNA
2" x .058 wall x 4' (45" exposed)
28.25"
10 Mtr Director #1, Element #7
212.5"
Boom is 18' x 2" OD
Note: 20 mtr element brackets are 4"x8"
all others are 3"x6"
Windload: 5.6sqft
Weight: 32 pounds
Power Rating: 5KW
Boom Length : 18'
Turning Radius: 19.8'
Wind Survival 80 mph (std)
Feed system: 1 feedline with 1:1 balun or RF choke
Direct 50 ohm feed
Copyright, Force 12, Inc., 2000
dwc3n1.001


Force 12
C-3S
20-15-10 (17 & 12) Multi-Monobander
(80 mph)
.375" .500" .625" .750" .875" 1"
36.25" 33" 33" 33" 33" 48"
20 Mtr Reflector, Element #1
0."
0.0"
.875" x 48" inner liner & splice (24" each side)
.375" .500" .625" .750"
41.25" 45" 33" 24"
15 Mtr Reflector, Element #2
23"
2" x .058 wall x 4'
2" x .058 x 48"
10 Mtr Refelctor, Element #3
65"
43.5" 45" 12" 6"
2" x .125" x 48"
(42" exposed)
Approximate Mast Location
FRONT of ANTENNA
2" x .058 x 48"
35.25"
15 Mtr Driver, Element #3
119.5"
21"
35.25" 33" 33" 33"
20 Mtr Driver, Element #5
130"
36.5" 45" 12" 6"
10 Mtr Driver, Element #6
136.5"
(all element brackets are 4" x 8")
Windload: 5.0 sqft
Weight: 26 pounds
Power Rating: 5KW
Boom Length : 11' 9"
Turning Radius: 18.9'
Wind Survival 80 mph (100, 120 and 140 optional)
Feed system: 1 feedline, 50 ohms with 1:1 balun or RF choke
Copyright, Force 12, Inc., 2000
dwc3s.001

C-31XR

20-15-10 non-trapped Yagi

Good friend just acquired (2) of these for $700

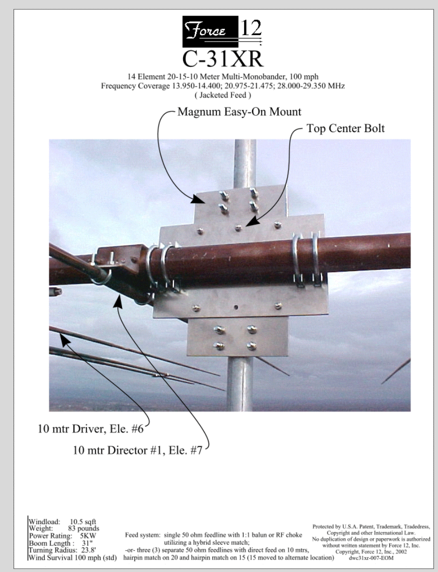


31' of heavy boom
(3) full size 20 meter elements (one split driver)
(4) full size 15 meter elements
(7) full size 10 meter elements (one split driver)
(15) Element brackets (2.5", 2.25", 2" boom dia)
and U-bolt hardware
Magnum Easy-On mounting plate assembly
Truss cable

~405' element tube and ~36' of heavy boom tube
6061-t6 extruded element tube 0.049" wall
__Tensile strength (PSI) 45,000 yield strength 40,000

Most today is 6063-t832 drawn tube 0.058" wall
__Tensile strength (PSI) 42,000 yield strength 39,000

(tolerances on extruded vs. drawn are noticeably different)



When you locate “old” antennas,

all the tubing/parts are likely to be assembled.

How to disassemble and clean?

Types of aluminum tube “out there”

Common/typical manufacturer’s element tubing

Most (today) is *6063-t832 drawn tube 0.058” wall*

__Tensile strength (PSI) 42,000   yield strength 39,000

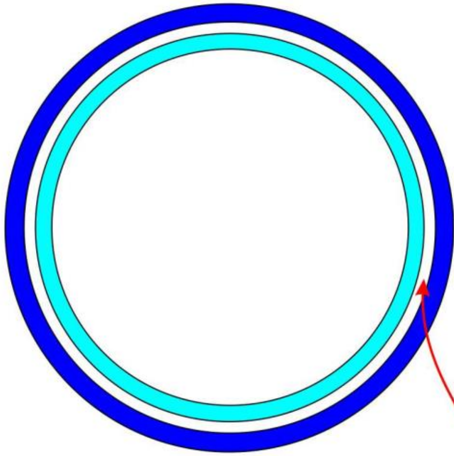
Force 12, Inc.   element tubing (>20% lighter than drawn .058” wall)

6061-t6 extruded tube 0.049” wall   (>5million lineal feet)

__Tensile strength (PSI) 45,000   yield strength 40,000

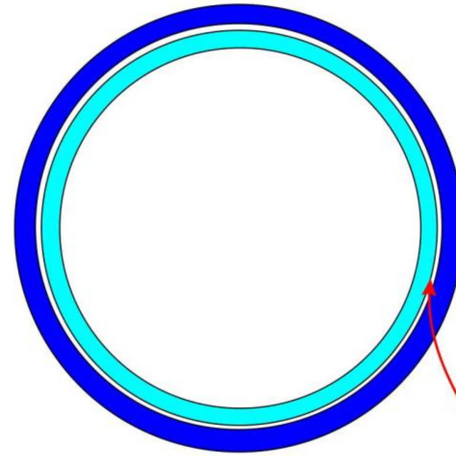
(tolerances on extruded vs. drawn are noticeably different)

Tubing
Force 12, Inc. extruded
0.049” wall



1.0” OD x .049” wall
ID = 1-(2x0.049)=0.902”
0.902” - 0.875”
0.027”/2 = 0.0135”

Tubing
HyGain & others
.058” wall



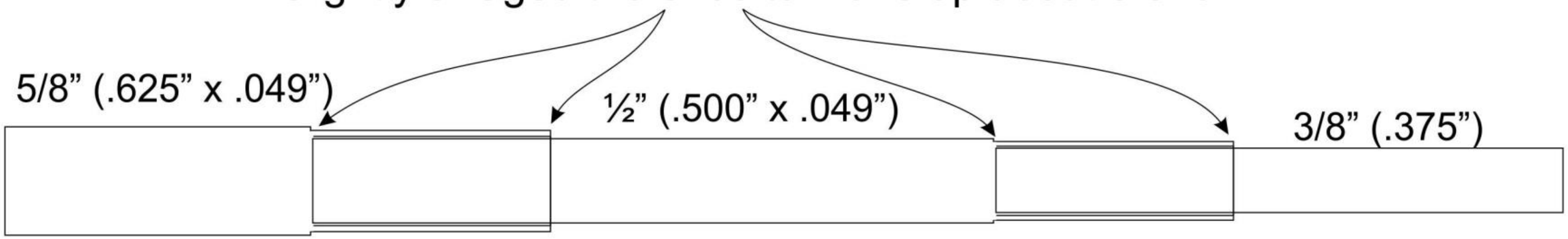
1.0” OD x .058” wall
ID = 1-(2x0.058)=0.884”
0.884” - 0.875”
0.009”/2 = 0.0045”

Extruded 6061-t6 0.049” wall is ~20% lighter & ~5% stronger
than 6063 t832 0.058” drawn x .058” wall
6061 1” x 0.049 x 12’ = 2.1 lbs
6063 1” x 0.058 x 12’ = 2.4 lbs

Tapered tubing
Force 12, Inc. and HyGain

Force 12, Inc. (1991-2008)

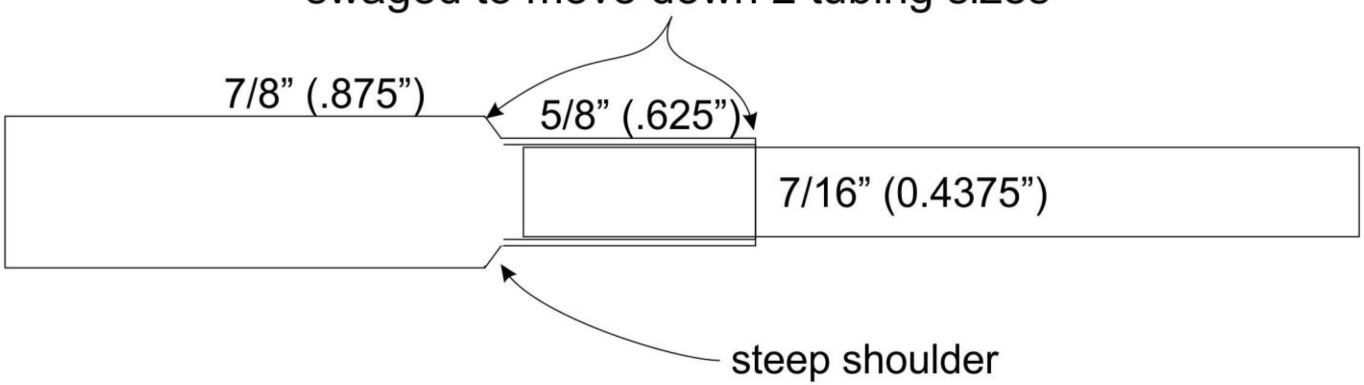
slightly swaged the ends to make up about 0.013”



note: a 0.013” gap is not 13 thou all around, it is 0.0065” around; therefore, swaged ~0.003”

HyGain

swaged to move down 2 tubing sizes



All the re-purposed tubing and parts have been in the environment.

__Tubing is likely to be assembled together; therefore, we need to:
__disconnect the junctions without damaging the tubing
__clean the junctions to ensure a good, new connection

__Types of tubing junctions
__sheet metal screws
__machine screws
__compression clamps of various designs
__ riveted

__Which junctions damage the tubing the most (5), least (1)?

__sheet metal screws	5 (pulls material into the gap)
__machine screws	3 (can compress the tube - oval)
__compression clamps	2 (dent outer tube into the inner)
__riveted	1 (leaves holes in the tubes)

How do you get the junctions apart?

__sheet metal screws – carefully unscrew, squirt lubricant into hole and slowly twist and pull the tubes apart, carefully file the holes

__machine screws – remove nuts, pull out screws, clean and check tube for being round

__compression clamps - unscrew and clean the outer tube

__riveted – see next page

Removing a Properly Installed Rivet

RIVET TOOL NOZZLE
<--Wrong one on left - hole is too large
Correct - small hole fits mandrel -->
(rivet shown dropping into nozzle)

To Remove a Rivet
(that has been properly installed)

____1) Use 1/8" drill bit
____2) Run drill slowly until rivet head comes off
____3) Remove rivet head from drill tip
____4) Drill through hole

____5) After drilling out the rivet, tilt the tubing so that the rivet body falls out; otherwise, it might rattle.

Titanium Nitride (TiN) coated

split point drill bits

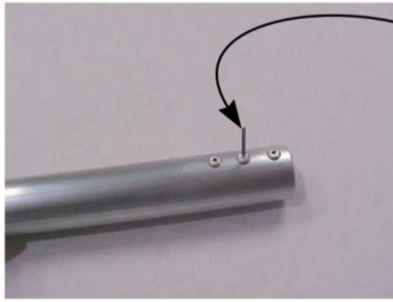
1/8” rivets

remove = 1/8” (0.125”)   new hole = #30 (0.1285”)

3/16” rivets

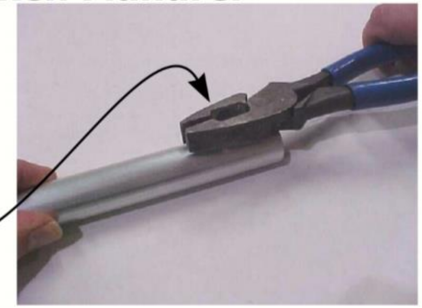
remove = 3/16” (0.1875”)   new hole = #11 (0.191”)

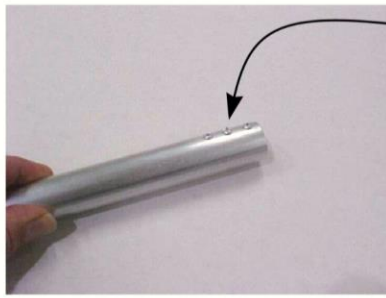
Removing a Rivet with a Broken Mandrel



___1) Broken mandrel

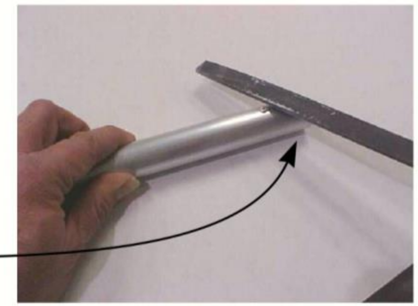
___2) Cut mandrel close to rivet head

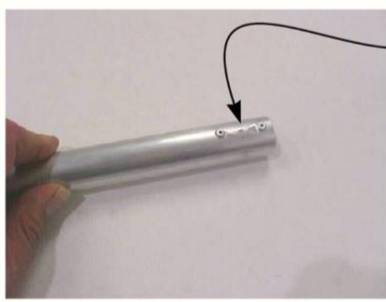




___3) Mandrel is now cut

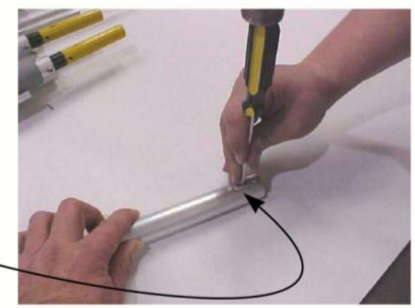
___4) File mandrel AND rivet head flush with tubing



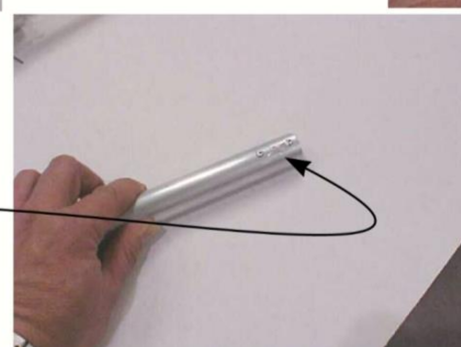


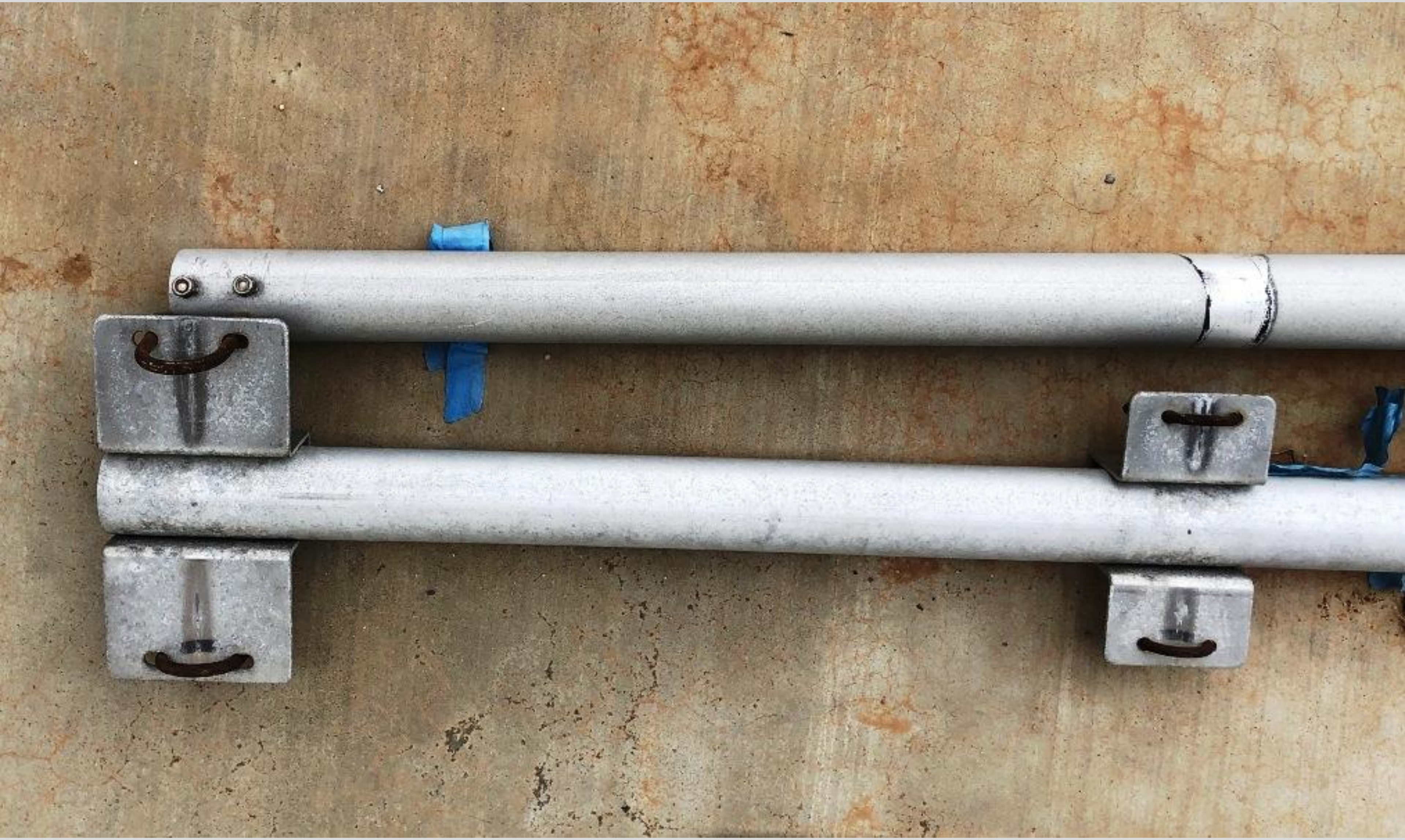
___5) Rivet head and mandrel filed off flush with tubing

___6) Punch rivet through with pointed tool (and hammer)



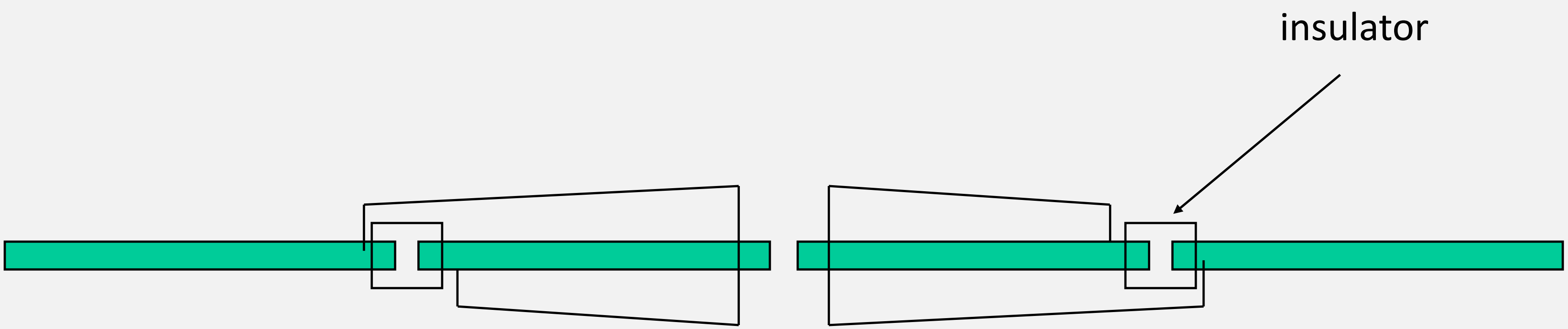
___7) Hole is now clear for new rivet.





Linear Loaded Dipoles

(HyGain, KLM/M^2, Force 12, Inc.)



In a dipole (1/2 electrical wavelength long)

_is max *current* at the center or ends?

__is max *voltage* at the center or ends?

Some physically short 40-meter dipole and Yagi elements
use linear loading to increase the electrical length

and

need to have a gap in the tubing to insert the linear loading.

HyGain 40 meter linear loading insulators.

The gap is no longer an insulator.
It has been filled in with carbon.

Happens with HyGain and KLM that are tubular (Force 12, Inc. insulators are solid)

Force 12, Inc. linear loading stand-offs are aluminum, hexagon, threaded for ¼-20.

solid fiberglass rod 40-meter linear loading insulators.

Stainless nuts and lock-washers work fine with plated U-bolts/saddles

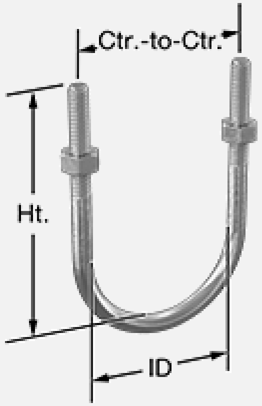
Force 12, Inc. Element U-bolts:

A. 1” diameter center elements, such as 20 meter reflector

1. These are often referred to as for 1" pipe. 1" pipe is an ID of the pipe, so the OD of pipe is much larger diameter and is about the same as the aluminum 1" covered by the PVC (also 1" ID like pipe).
2. ID = 1 3/8" (has to go over the PVC that is over the 1" tubing center section)
   Center-to-center = 1 11/16"
   Thread length = 1"
   Height = 2 3/16"
   Thread is 5/16-18

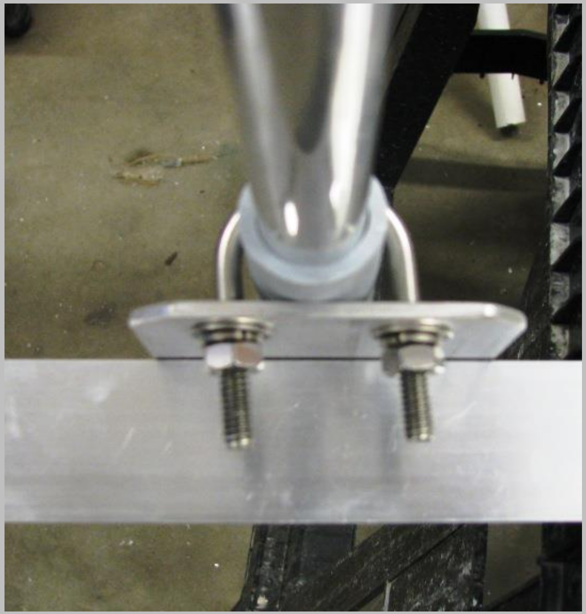
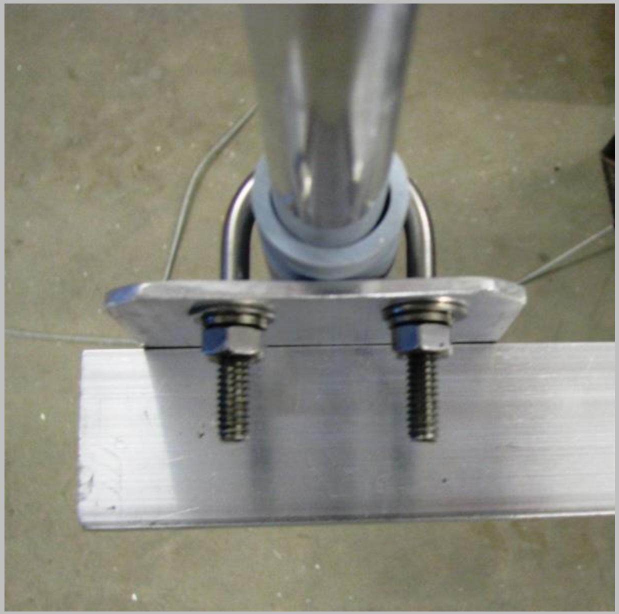
B. 1 ¼” diameter center elements, such as heavy-duty 20 meter reflector

1. Often referred to as for 1 ¼" pipe. 1 ¼" pipe is an ID of the pipe, so the OD of pipe is much larger diameter and is about the same as the aluminum 1 ¼" covered by the PVC (also 1 ¼" ID like pipe).
2. ID = 1 3/4" (goes over the PVC that is over the 1 ¼" tubing center section)
   Center-to-center = 2 1/16"
   Thread length = 1 1/8"
   Height = 2 11/16"
   Thread is 5/16-18



C. .750” (¾“) diameter center elements, such as typical 15 and 10 meter elements

1. Often referred to as for ¾” pipe. ¾” pipe is an ID of the pipe, so the OD of pipe is much larger diameter and is about the same as the .750” aluminum covered by the PVC (also ¾” ID like pipe).
2. ID = 1 1/8 " (goes over the PVC that is over the .750" tubing center section)
   Center-to-center = 1 3/8"
   Thread length = 1"
   Height = 2"
   Thread is 1/4-20

Drilling holes for bolts, U-bolts (for example):

__a 5/16” bolt can survive with a 5/16” hole, but a 5/16” U-bolt needs slightly larger than 5/16” holes;
______a 3/8” bolt can survive with a 3/8” hole, but a 3/8” U-bolt needs slightly larger than 3/8” holes.

Typical drill bits are a 2-flute design and actually drill triangular holes.


0.001in


mm/in/F
0.8145 in
OFF
ON
ZERO

$35

9 amp, 7 ¼” compound miter saw $119.00

(not the sliding style)

14amp, 10” compound miter saw $149.00
(not the sliding style)

$70

$110

Deburring tool

NOALOX

aluminum to aluminum or
aluminum to copper
connections

Home Depot, etc.

Aircraft Spruce
SINCE 1965
& Specialty Co.

Belt sander, 36” x 4” belt
$90-180

Tube and Pipe info

1. Tubing diameters are outside dimension (OD)

2. Pipe (i.e. PVC) diameters are inside dimension (ID)
____however, a 2” aluminum tube will not necessarily fit inside a 2” pipe
_____it depends on the wall thickness of the outer piece.

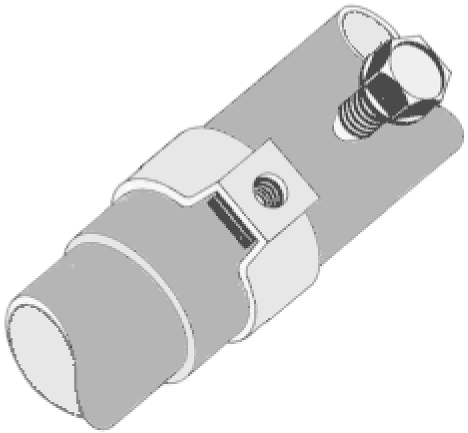
3. To sleeve a 2” tube, a 2.125” x 0.058” wall will slide over the outside.
____If the 2” tube has an 0.058” wall, a 1.875” tube will slide inside.

4. To make a “thick wall” boom:
____center is 2.5” tube, 0.120” wall, slides over 2.25”
_____the 2.25” tube with 0.120” wall slides over 2” tube

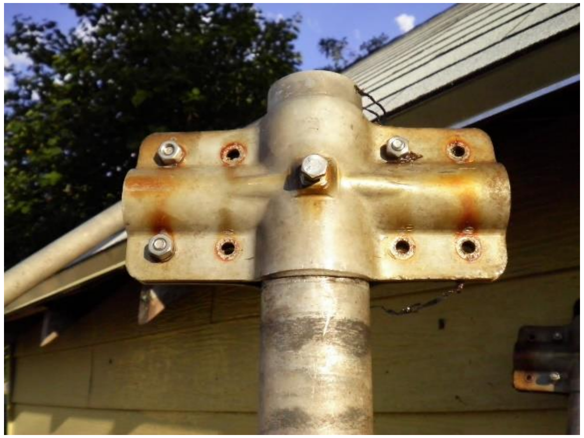
5. Extruded tubing is not seamless and the dimensions are quite variable, as the tolerances are “loose.”

6. Drawn tubing is seamless with close tolerances and can be telescoped in typical antenna diameters as long as the wall is 0.058, or 0.120”

7. Extruded tube is typically a 6061-t6 alloy, which is stronger than drawn tube that is 6063-t832 in the same wall thickness.
___6061-t6 tube with 0.049” wall is stronger than a 6063-t832 with a 0.058” wall.
____ A 0.049” wall extruded tube element will be lighter weight compared to 0.058” wall drawn tube element.
_____Extruded tubing joints are more difficult to make, as the 0.049” walls leave a gap, as compared to the 0.058” wall tube.

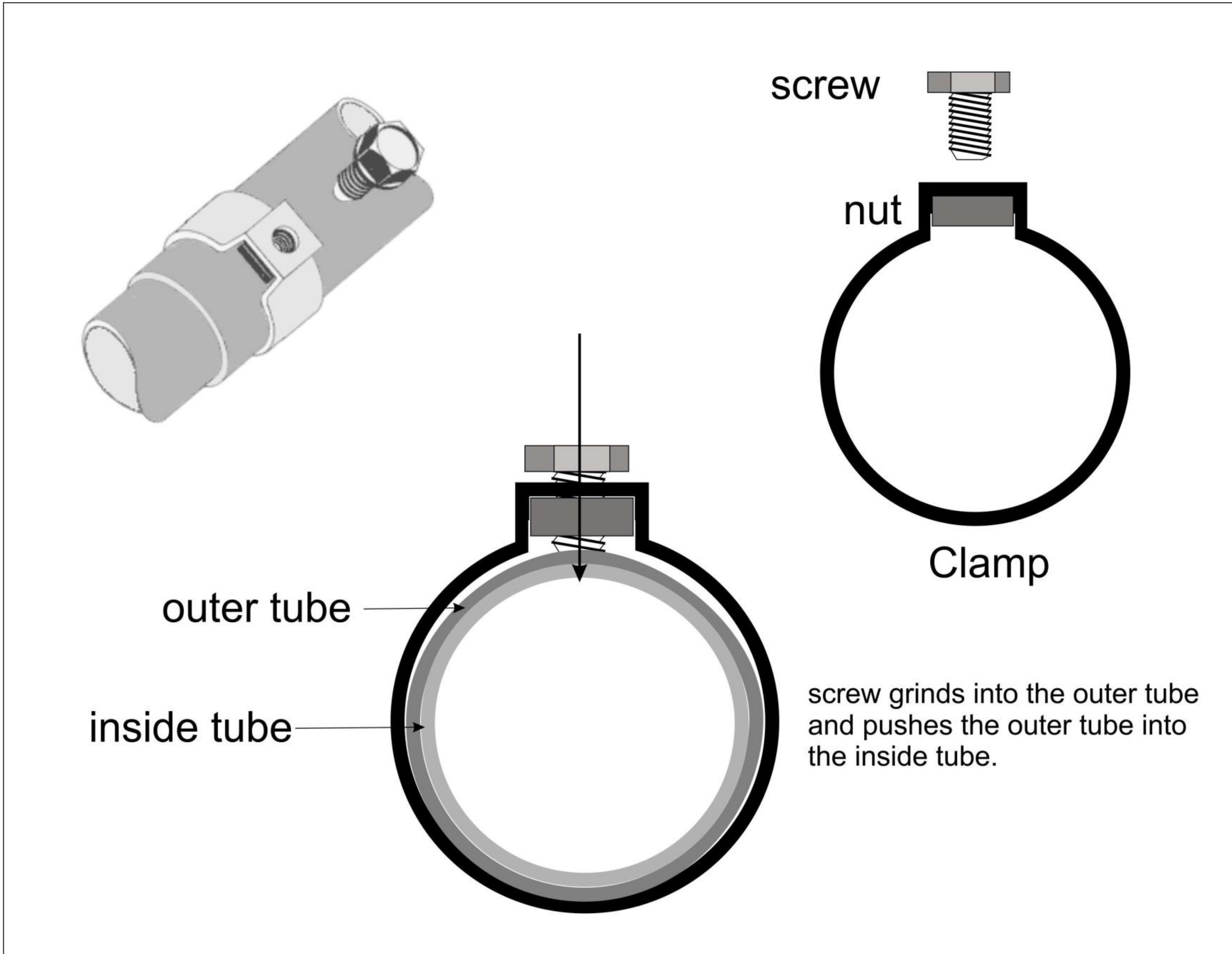


HyGain compression clamp



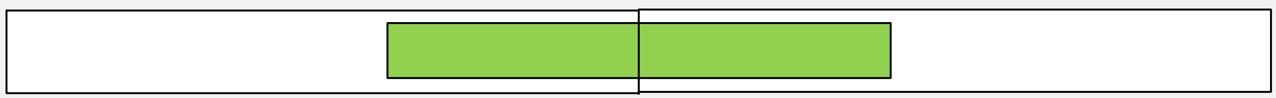
HyGain element mount
clamps around the boom

compression clamp joint
maybe HyGain, CushCraft

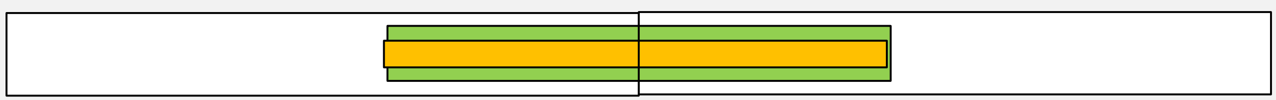

screw
nut
Clamp
outer tube
inside tube
screw grinds into the outer tube and pushes the outer tube into the inside tube.

Splicing element centers

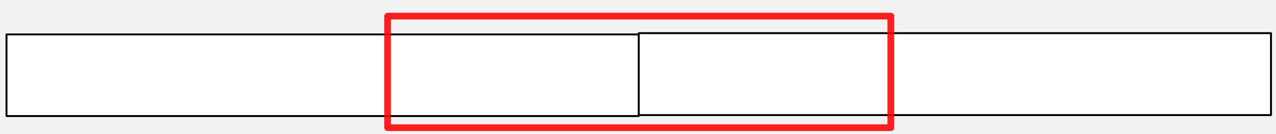
Inner sleeve will fracture over time



Much better

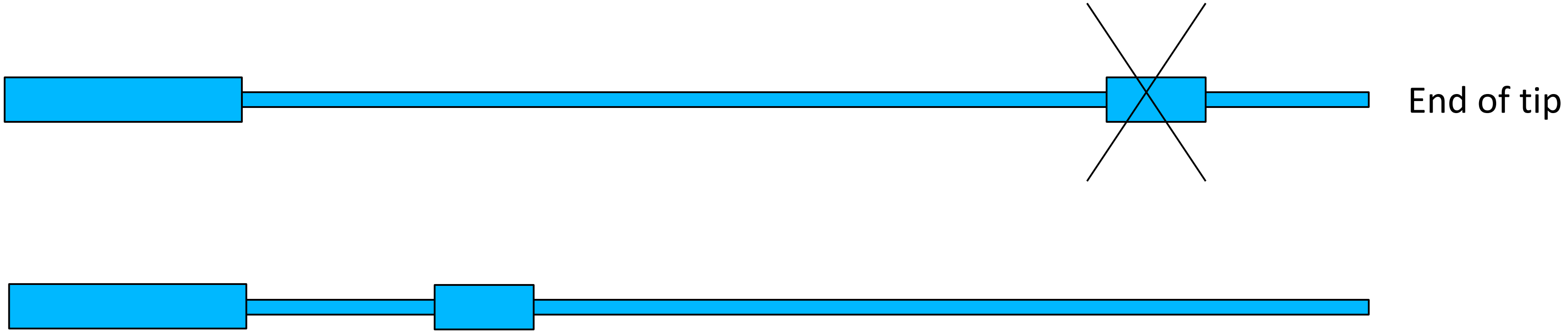


Outer sleeve is best



Extending an element tip

use an outer sleeve and splice close to the next larger tube

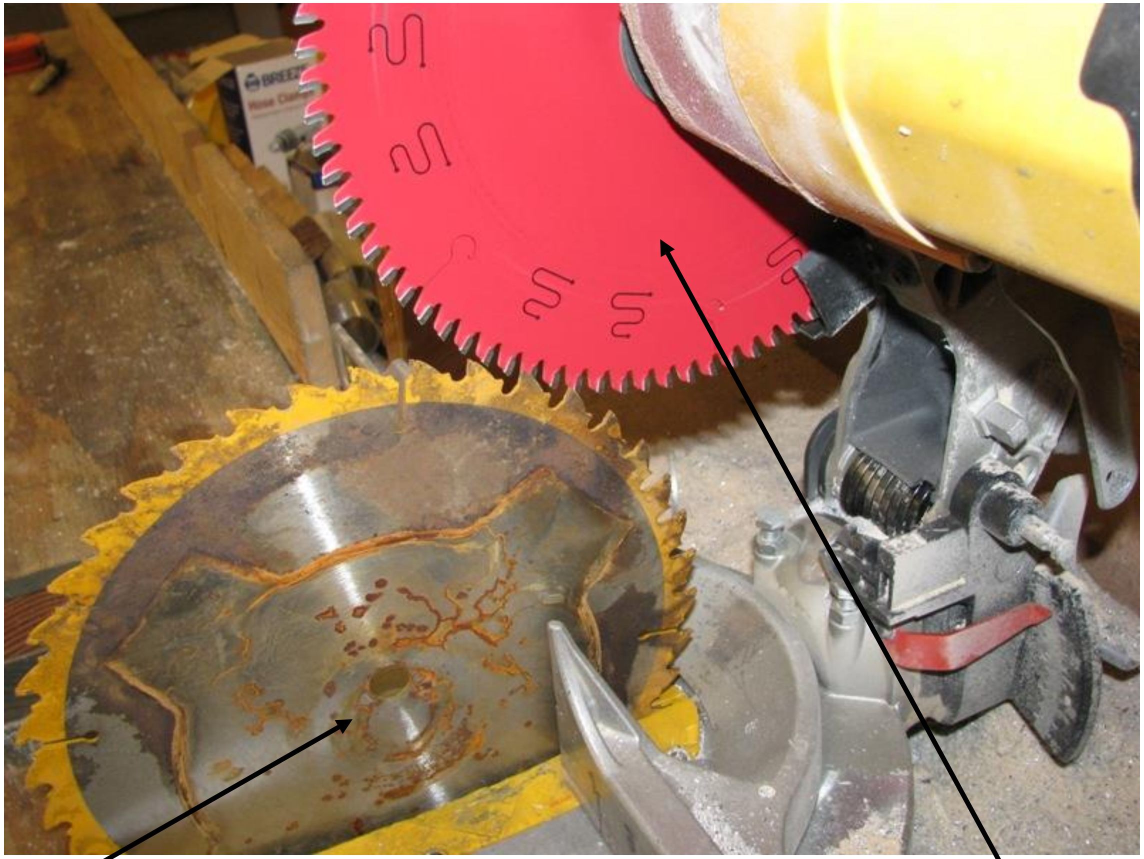


Working with tubing.

How do we cut it?

I use a 10” miter saw

with an 84-tooth blade for non-ferrous material.



“Regular” blade - for wood.

Blade for non-ferrous material (aluminum).

Note the correct direction of the teeth on the red blade.

Never cut a "double tube".

When the blade reaches the inside tube, the teeth will dig into it and try to spin it inside the outer tube.

The result will be a big "BANG" with pieces flying.

The blade is turning 5,000 rpm.

With a 10" diameter blade, the teeth are traveling 157,000 inches per minute, which is 13,083 feet/minute, or 2.48 miles per minute, equaling 148.7mph.

There is a LOT OF KINETIC ENERGY in the blade.

Always keep the blade through the cut until the saw brake stops the blade.

<u>You are holding the left-hand side of the tube and the cut-off piece is loose.</u>

Lifting the blade too soon can cause a tooth to hook the cut off piece and throw it – usually some place you don't want.

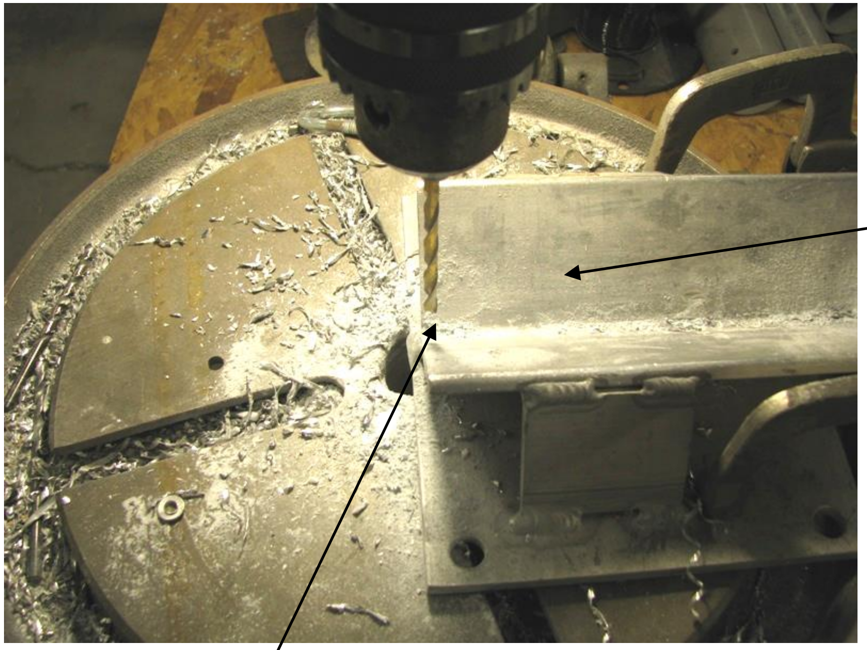
→Do not cut fiberglass on this saw ←

This is an outer coupler, such as on a boom, and half is riveted in place with 3/16” rivets. The other half will receive 1/4-20 through bolts.

How do you drill on a tube?

I’m glad you asked!

Utilize a V-block on the drill press to drill tube.



V-block

made out of welded aluminum angle stock.

Drill bit is centered in the V and back slightly from the end of the V-block (and hole in the drill platform)

to allow chips to fall away.

Rivets

How many 1/8” rivets did we use on elements?

>4,400,000

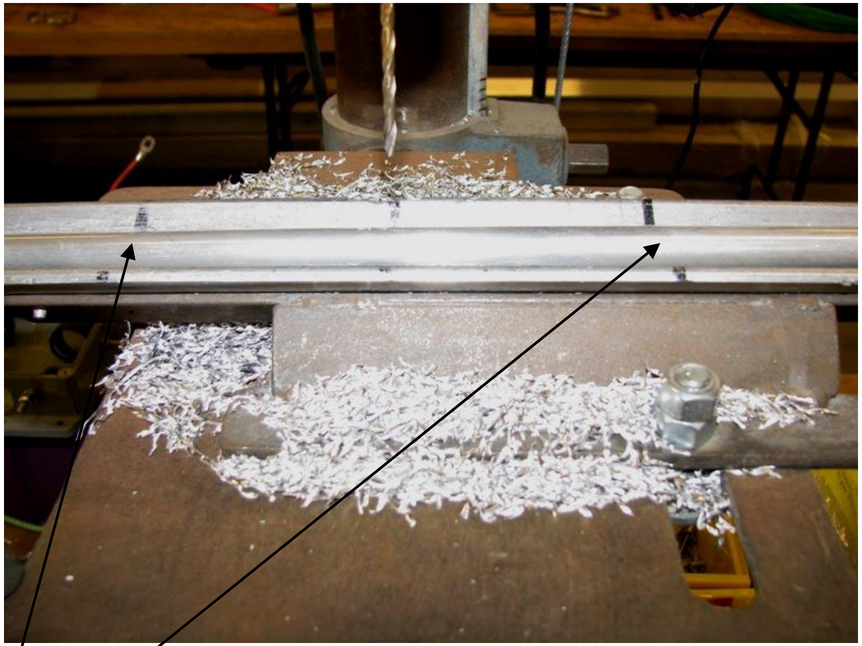
Add at another 1,300,000 3/16” rivets for brackets and booms.

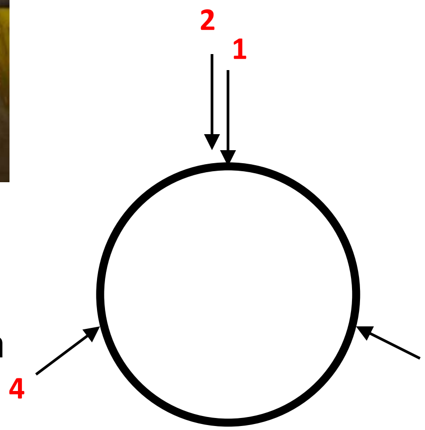
…pushing 6 million rivets in the field all over the world

and the elements have stayed up in locations in all kinds of weather.

(“closed end” rivets)

A smaller V-block for smaller tube, such as for drilling rivet holes in element sections.





Note the markings on the V-block to avoid having to measure each time for a standard distance.

Markings are 3" each side of center for a 3" tubing insertion length.

2 holes are drilled in line about 3/8" in from the ends, plus 2 more holes at about 120º on each "side" of the original 2 holes line.


"cheap tape"
not cheap
Commercial Electric
VINYL ELECTRICAL TAPE
60ft
Scotch
Super 33+


SUPERIOR
LUBRICANT
LUBRICANTE
SUPERIOR
CRAFTSMAN
CRAFTSMAN
STANLEY
FatMax
25


DEWALT
IRWIN
IRWIN
VISE-GRIP
makita
LXT
makita
2.0Ah
18V
Milwaukee


Forney Easy Weld
MIG
EASY WELD
Lincoln TIG 200
TIG 200
Miller Synchrowave 250DX
ncrowave 250 DX

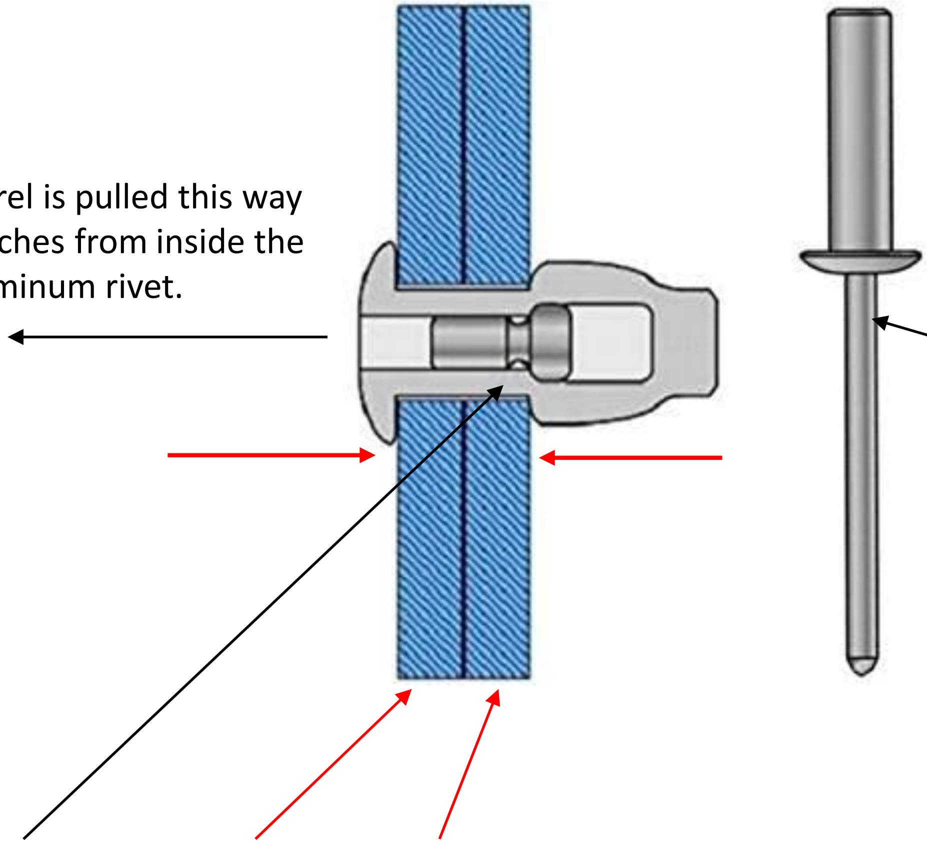
Common “blind” rivets

Typical rivet, with ball on end.

Not for antennas!

Closed-end Rivets

Steel mandrel is pulled this way until it detaches from inside the aluminum rivet.



Aluminum body -- not stainless.

Steel mandrel pulls harder before detaching for the strongest joint.

Rivet pulls outer and inner tubing together for solid contact and a secure aluminum-to-aluminum joint.

Titanium Nitride (TiN) coated

split point drill bits

1/8” rivets

remove = 1/8” (0.125”)   new hole = #30 (0.1285”)

3/16” rivets

remove = 3/16” (0.1875”)   new hole = #11 (0.191”)

Closed-end Rivet tools

Hand rivet tool for 1/8″
rivets (1/8″ rivet body.)

Great pneumatic tool by POP (expensive)

Hand rivet tool for 3/16″
rivets (3/16″ rivet body.)

Inexpensive pneumatic rivet tool that will work for
most all projects. Will pull up to 3/16″ rivets.

(Don't use the rivets that come with it.)

Where to get closed-end rivets

McMaster-Carr

https://www.mcmaster.com

Inexpensive rivet tools can be found at many places, including those on-line on the left and also at stores like Lowe's, Home Depot and Harbor Freight.

Olander

http://www.olander.com

Stanley Engineered Fastening

http://www.stanleyengineeredfastening.com/brands/pop/rivets/types/closed-end-rivets

In all rivet tools, use the <u>smallest</u> nozzle for the particular size rivet and mandrel.

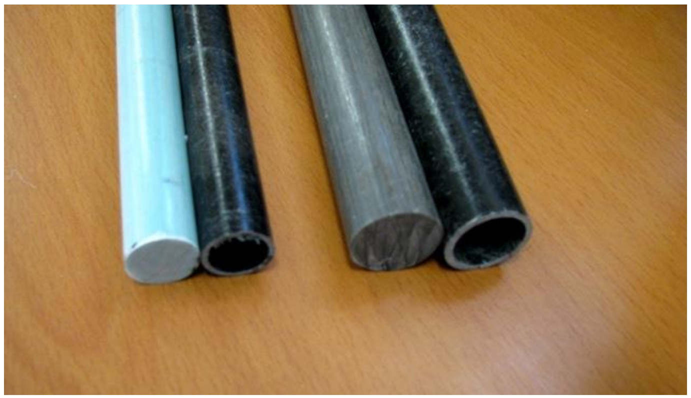
Rivets and shearing forces.

An example is a vertical with several sections, with gravity continually "pulling down" on all the sections.

If the vertical sections are lightweight, enough rivets can be sufficient; however,
if the vertical sections are heavy, or cumulatively heavy
(e.g. at the lower sections of the vertical),
rivets might not be adequate for the shearing forces.

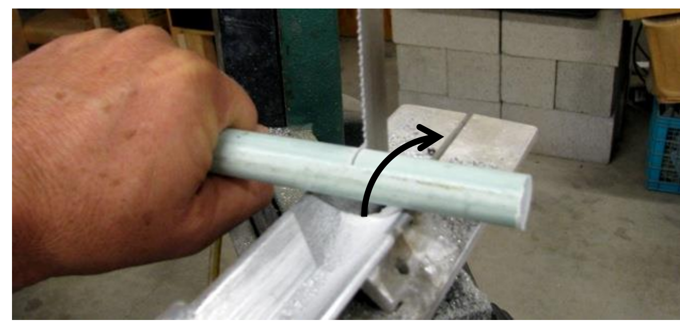
In this case, machine screws or bolts are the right selection and
be sure the tubing walls are thick enough not to be (overly) compressed.

Fiberglass for Yagi split driver centers and air core coils.



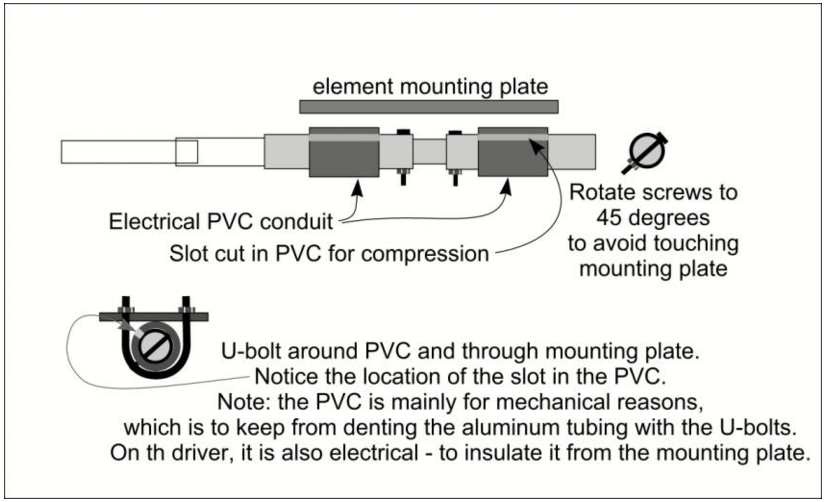
Fiberglass can be tube or solid rod.

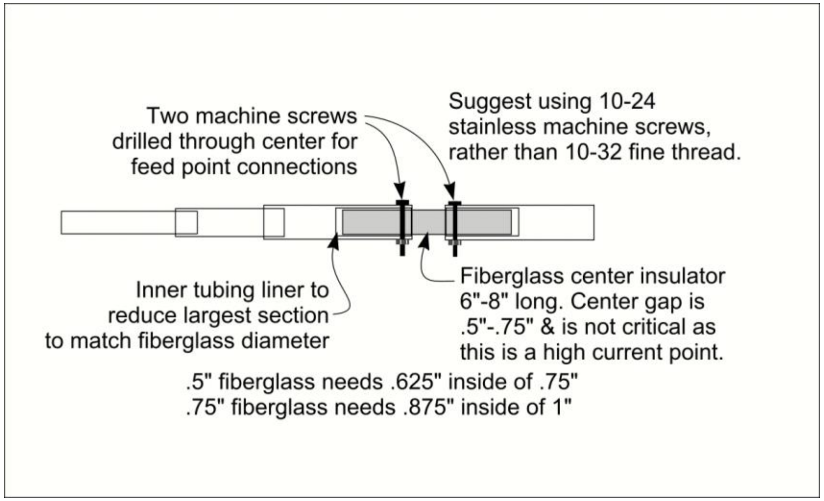
For HF element centers, use rod.

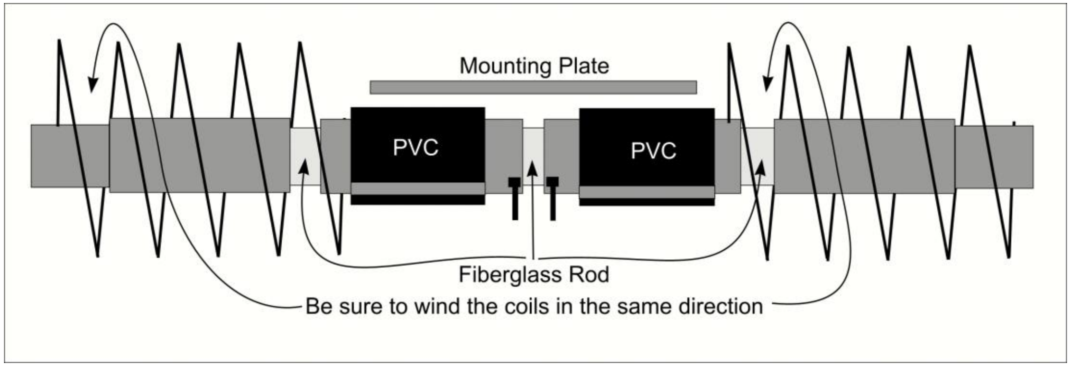


Roll the fiberglass into the band saw blade - use 2 hands!!

Yagi split driver centers







Cutting a slot in the end of tubing on a band saw.

Hold it securely, especially when backing out.

De-burring tool to clean up the inside edge of an aluminum tube.

A belt sander with 120 grit will clean up the outer edge.

Did not include a hack saw – a last resort,

mainly because it is difficult to make a straight cut.

Did not include a tubing cutter –

lots of filing on the inside (and maybe outside) of the cut.

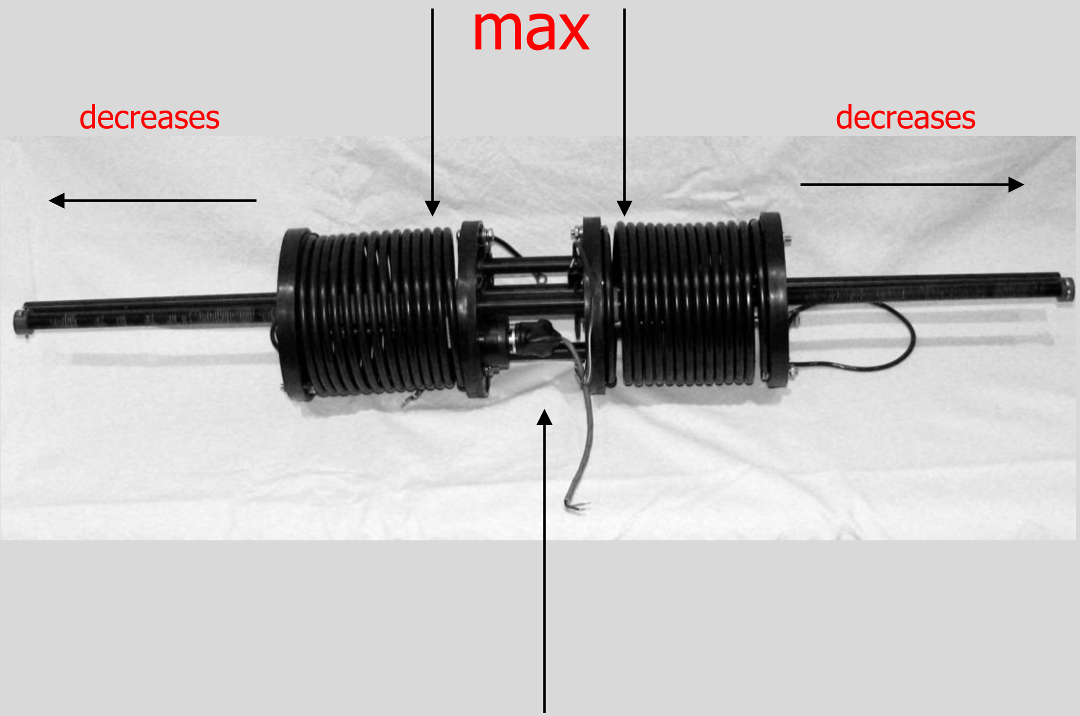
⚡ We interrupt this message for a special announcement ⚡

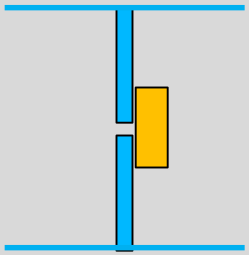
Where is the high current location in a dipole?

If we are using a loading coil in each leg of a dipole at the center, where is the highest current?

Where is the high current location in a dipole?

If we are using a loading coil in each leg of a dipole at the center, where is the highest current?





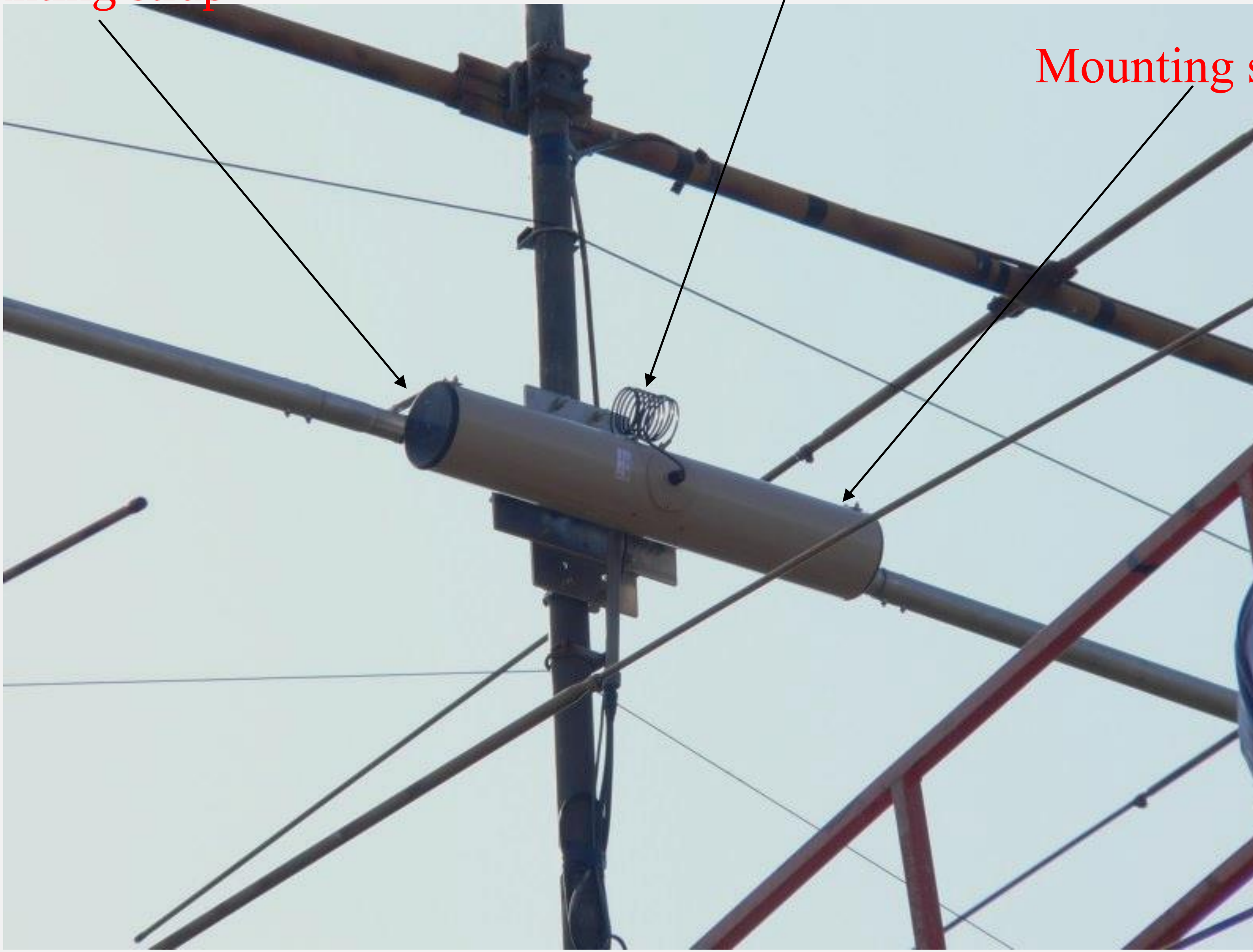
Tornado original design was for the Force 12, Inc. Sigma 8040, which is a full size 40-meter vertical dipole using the Sigma design:

36’ tall with T-bars, top/bottom.

Adding identical air-core coils on each side of center allowed it to also cover 80/75 meters with the Tornado motor drive and internal switch.

The Tornado was then offered as an option for horizontal 80-meter dipoles to move all around the band, w/o relays & fixed coils.

N6TV antenna array


Mounting strap
Feed Point
Mounting strap

⚡ ***Now back to our regularly scheduled programming*** ⚡


Get Some!

Get Free

Get Used

Repurpose

Make

NEW from OLD

Pattern

directed antenna pattern
vs
random antenna pattern

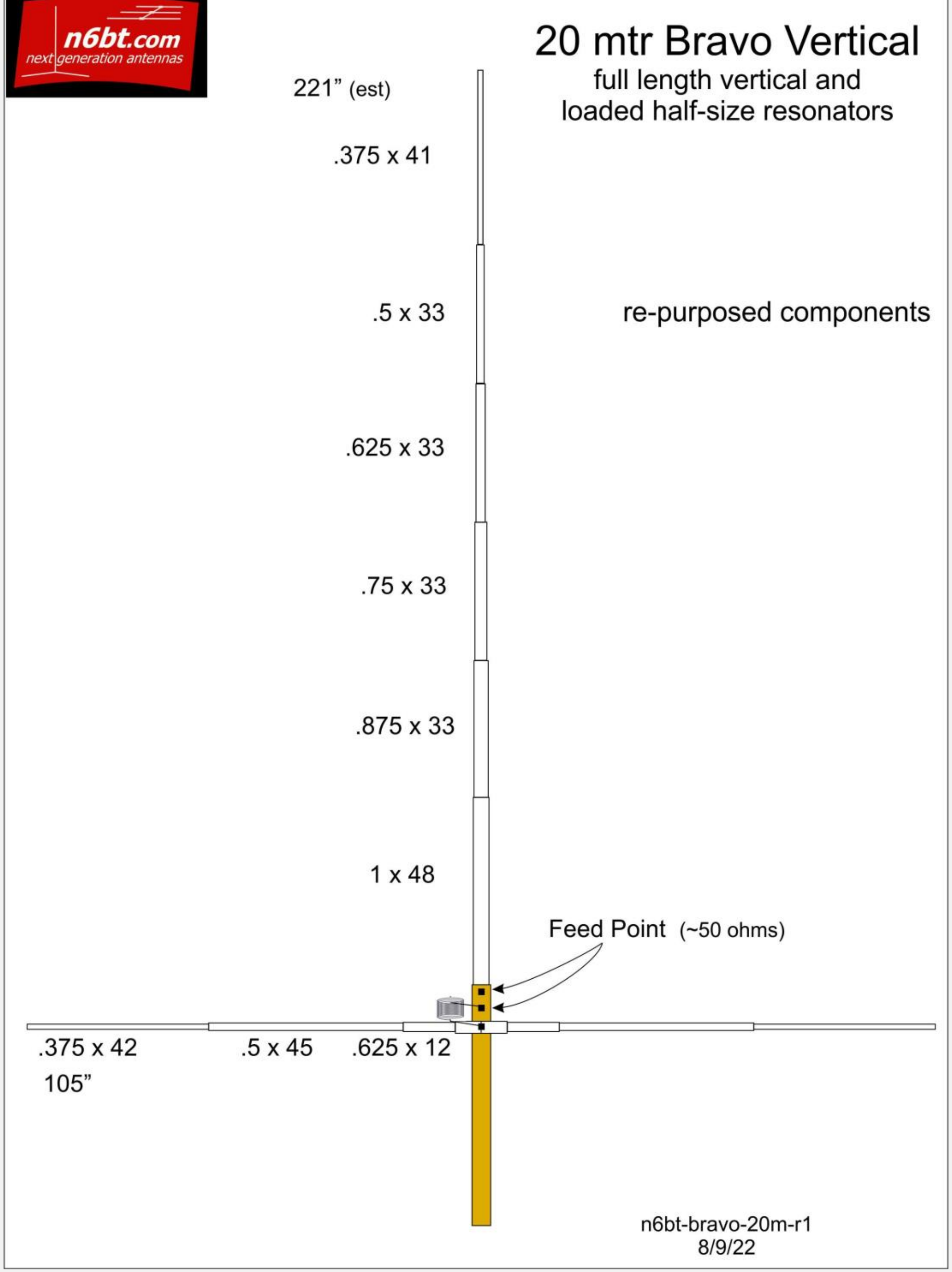
Repurposed

into
high efficient
Vertical

Half a 20 mtr element, plus
(1) 10 mtr element
makes a full size
Bravo 20 mtr vertical

Then:

One full 20 mtr element,
plus (2) 10 mtr elements
makes a 2 element full size
Bravo 20 mtr vertical beam
(phased or parasitic)



2el rotatable

single or
multi-band

Without ground contact and no horizontal sections, multi-band vertical dipoles can be paired for a low profile, rotatable gain array.

This 2 element is manual band change for 20-17-15-12-10 meters.

Hub of proto-type multi-band vertical using open rings

(3) fiberglass spreaders, clamp-on spreader mount and element bases (15 shown)

Full length radiators and full length open rings
(only 20 and 15 meters so far)
Efficiency 98%

(power limited by the balun)

ZS1DX 30 Mtr VOR

Fiberglass vertical w/wire and wire VOR

ZS1DX 30 Mtr counter-rotating VOR

Counter-rotating ring makes azimuth pattern perfect.

Easy to make 20 meter full size vertical and VOR
Either a single, or a 2 element parasitic

If you have an antenna like this and do not want to lay down ground radials,

use concentric open rings

7 bands, 40 – 10 and gain efficiency

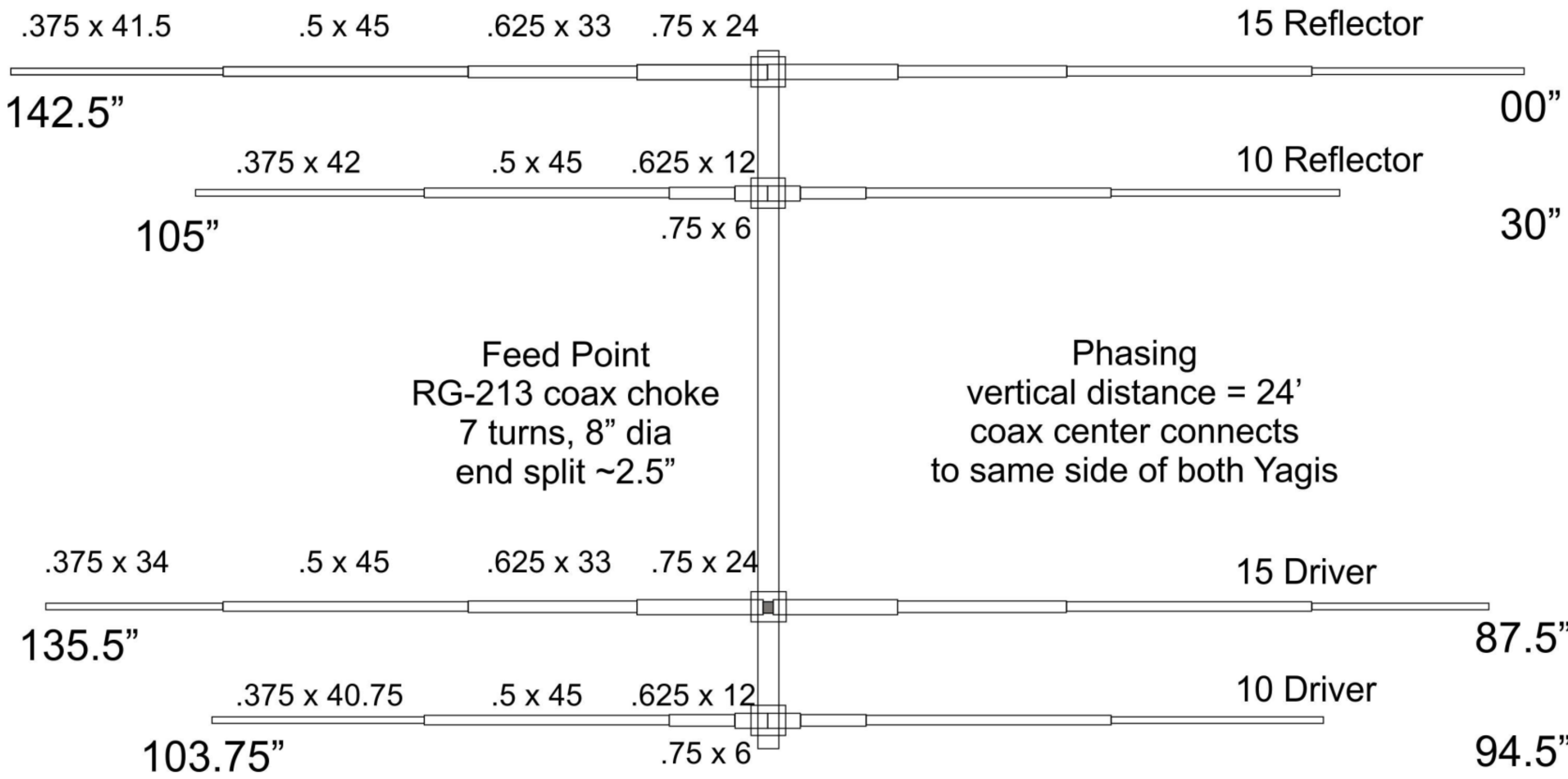
Repurposed

into
10/15 Yagi
stack

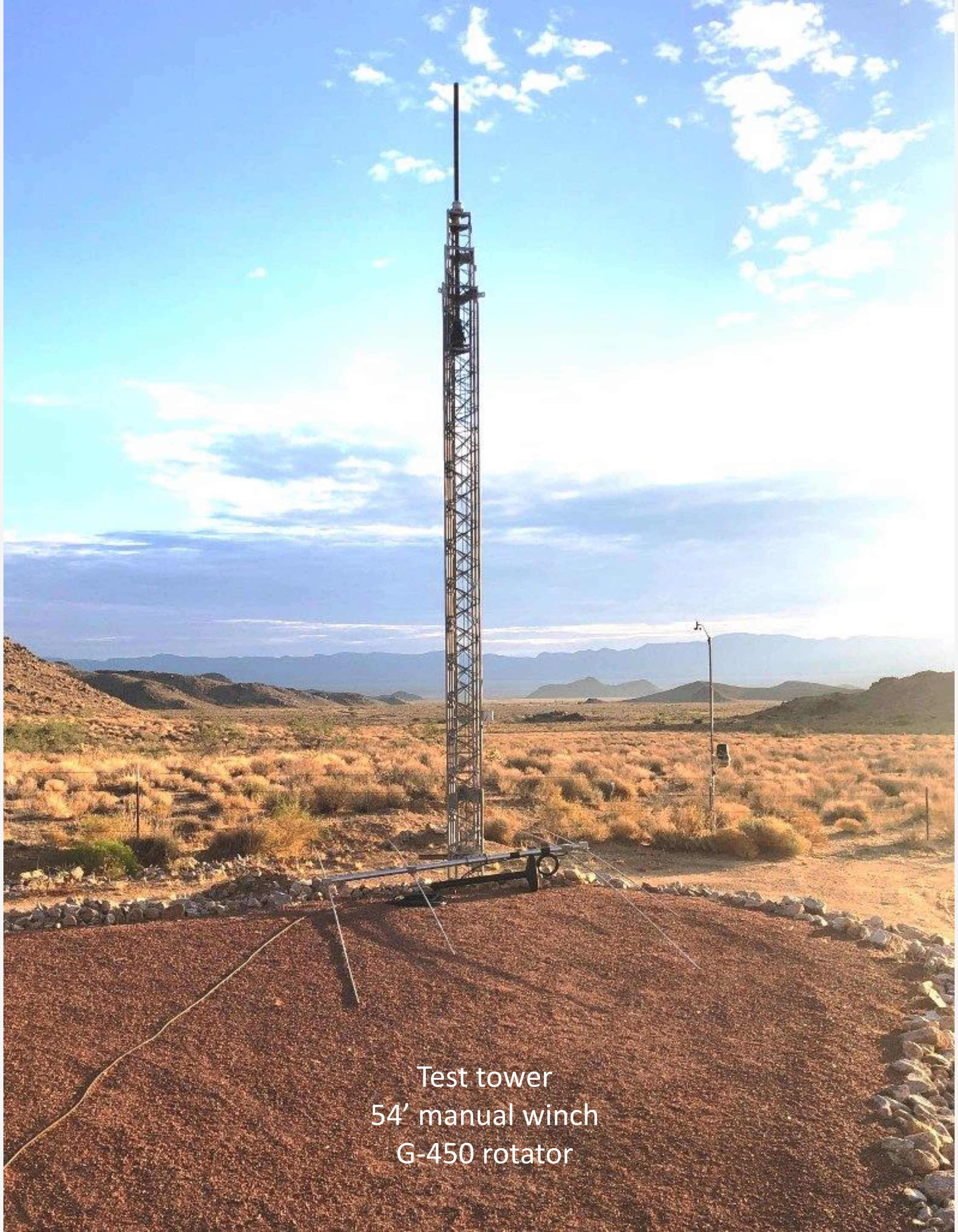
10/15 Duoband Yagi

2el 10mtr and 2el 15mtr
Open Sleeve feed to 15 driver
element brackets 3”x6”
Boom: 8’ x 2”

re-purposed components
elements and brackets
are Force 12, Inc. circa1993
boom is from Hang Glider



n6bt-1015-yagi-r2
8/9/22


Test tower
54’ manual winch
G-450 rotator


CLARK


CLARK
CLARK


Stack aimed at 40°

“Verticals are poor antennas and radiate poorly in all directions.”
who? when?


“Verticals are poor antennas and radiate poorly in all directions.”
who? when?

It seems like Lew McCoy, W1ICP, popularized the saying in an article he wrote in September QST 1972, but it started before then.
In his article, he wrote, “You’ll hear the statement from fellow hams that verticals are poor antennas and radiate poorly in all directions. This isn’t true because a vertical can be a good antenna, but you have to give it a fighting chance.”

As founders of Team Vertical, Kenny (K2KW) and I experienced a sea change when we went to Jamaica in 1997 for the ARRL DX CW contest. On 20 m we had a wire Yagi and 2-ele vertical - the vertical dominated – as it did on all bands. This was when we started to wonder about conventional wisdom for both vertical antennas on the high bands and the role of take off angles from the Caribbean.
After setting more than 20 World Records, we certainly endorse his comment.

More research spanning 25 years shows that vertical antennas can certainly be excellent performers:
__high efficiency using the correct current return and components
___gain arrays for both parasitic and phased arrays
____offering low take-off angles
_____receiving enhancement from being adjacent to sloping ground
______the ultimate DX antenna when placed in correct proximity to salt water

http://www.iw5edi.com/ham-radio/4543/some-plain-facts-about-multiband-vertical-antennas

Discoveries to date about vertical antennas

1. The ground is not your friend - keep the vertical and horizontal components off the ground;

2. Linear loaded verticals are highly efficient;

3. 1/4 wave ground radials are actually ~25-30% too long, which places the maximum current in the ground, rather than in the vertical;

4. Verticals using 1/4-wave ground radials usually get shortened, ensuring that the maximum current is in the ground (shorten the radials, instead);

5. A “classic vertical” will be ~7dB down from a vertical with elevated, tubing radials;

6. The take-off angles for vertical antennas have been measured to be substantially lower than the computer model indicates;

7. Verticals by salt water have energy down to the water (<1°);

8. Verticals adjacent to sloping ground have energy that follows the slope and measurements on sloping ground of 8-12º show that the vertical has energy at and below the horizon;

9. Measurements comparing full size (asymmetric) vertical dipoles to full size horizontal dipoles shows them to be within the margin of error in field strength, meaning that the often-quoted 6dB of ground reflection gain for the horizontal is not seen;

Discoveries to date about vertical antennas

10. The most efficient vertical is a full-size vertical dipole (90 ohms);

11. The most efficient compressed size vertical is the ZR design, because it is an electrically full size, half-wave element;

12. A full size Sigma is almost identical to the ZR, but shares the same awkward feed point in the middle of the vertical element;

13. Asymmetric vertical dipoles are user friendly with the feed point at (or close) to the bottom;

14. Asymmetric vertical dipoles can be built as rotatable beams (no tower);

15 A 2el broadside vertical array has reasonable (~4dB) gain to a single and a narrow beam pattern, making it quiet on receive and broad-banded;

16. Asymmetric vertical dipoles, as well as other verticals that are asymmetric, have a current imbalance that causes balun heating and a loss of energy;

17. The 2017 Gen-7 vertical design is a balanced current, physically asymmetric vertical dipole that does not heat up the balun;

18. VOR is as effective as (2) full length Gull-Wing radials (modeled within 0.1dB) and takes up less space.

19. Verticals do not necessarily need to look like an antenna.

Discoveries to date about vertical antennas

** main items **

5. A “classic vertical” will be ~7dB down from a vertical with elevated, tubing radials;

6. The take-off angles for verticals have been measured to be substantially lower than the computer model (i.e. NEC-2, AO, etc.) indicates;

7. Verticals by salt water have energy down to the water;

8. Verticals adjacent to sloping ground have energy that follows the slope and measurements on sloping ground of 8-12º show that the vertical has energy at and below the horizon;

9. Measurements comparing full size (asymmetric) vertical dipoles to full size horizontal dipoles shows them to be within the margin of error in field strength, meaning that the often-quoted 6dB of ground reflection gain for the horizontal is not seen;

18. VOR is as effective as (2) full length Gull Wing / straight radials (within 0.1dB) and takes up less space.

19. Verticals do not necessarily need to look like an antenna.

Additional detailed research by N6LF, see also QEX

A word of CAUTION

Antenna High Voltage

Attic dipoles: → high voltage is at the ends can start a fire
→ ends of all dipoles are high voltage

Verticals: → roof-top radials can have high enough voltage to ignite wood shingles
→ horizontal resonators (like on a Bravo), high voltage is at the tips

Magnetic Loops: → high voltage is opposite the feed point and is very high

"Perimeter wires": → can have multiple voltage maxima, depending on the length

The lower power we run, the more important our antenna.

Especially true on the low bands.

What’s the most improvement (for the smallest investment)?

Adding one more element:

Either phased or parasitic,

this will add between 3 and 4.5dB over the single element.

Team Vertical will all affirm that 2dB is a “ton.”

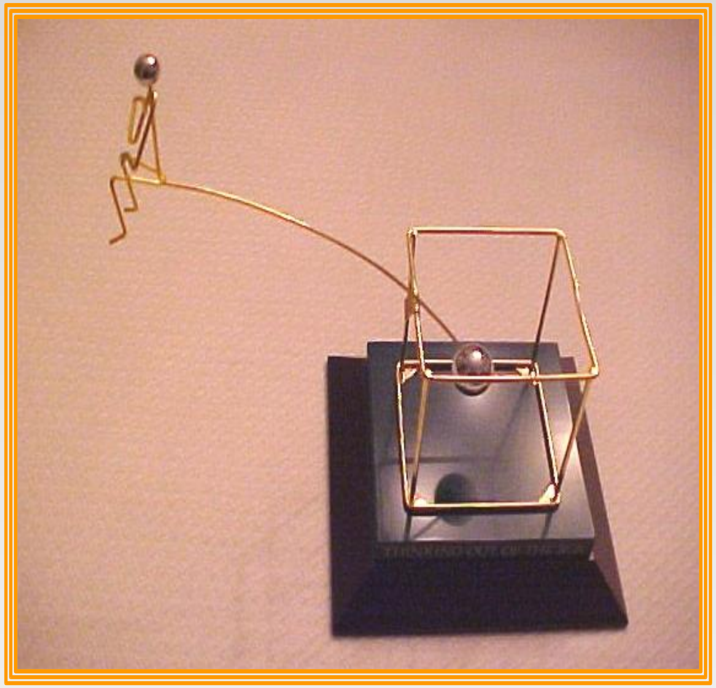
Whenever we could find 2dB, we would do it, because:
it adds another <u>layer</u> of stations to work.

Thoughts for the day:

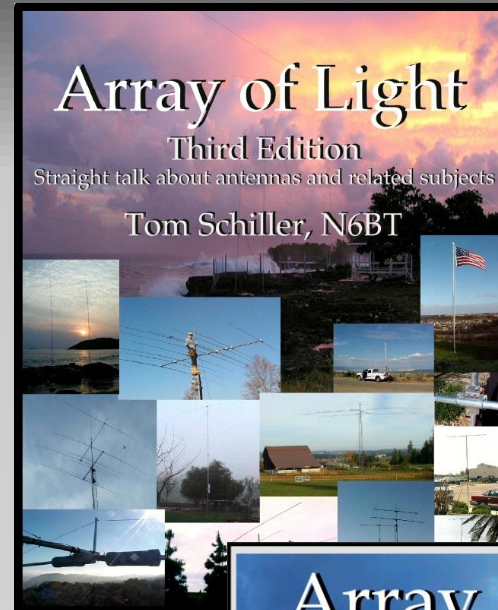
“Everything Works”

...and...

Think out of the box

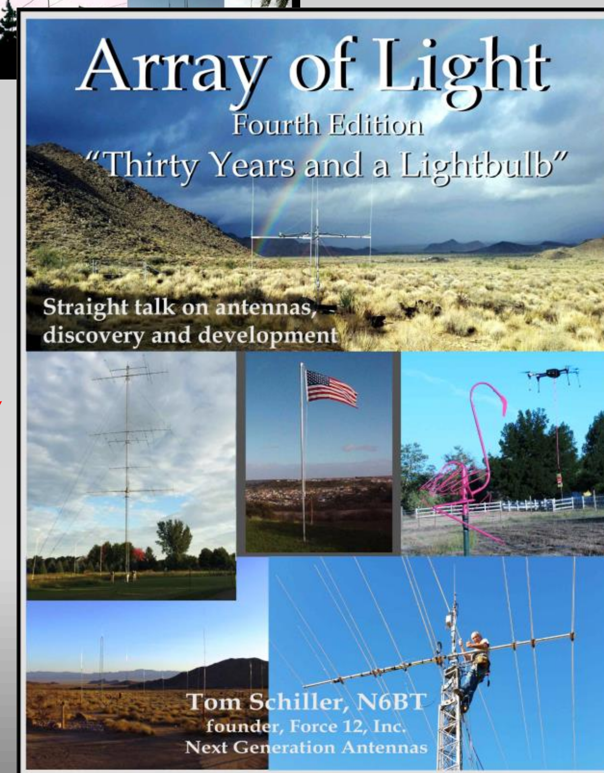



The future of amateur radio is the youth.



Available

on line



Thanks for your attention

Tom N6BT

New

4th Edition

n6bt.com
next generation antennas™